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THE SIZE OF OCEAN WAVES.

By VAUGHAN CORNISH, M.SC.(VICT.), F.C.S., F.R.G.S.,
Associate of the Owens College.

"The heights of waves and their velocity are subjects on which observations are never amiss."—*Vide Admiralty Manual of Scientific Enquiry.*

OF all the phenomena of our physical environment what is so fascinating yet elusive as a wave! Since the earliest days the voyager returned has told about the waves he met, and their bigness, yet even now we cannot get an answer which shall be at once short, clear, and accurate to the question—what is the size of the waves in a storm at sea? I propose in these articles to describe in some detail what has been done towards answering this question, which, as I know from my personal experience, excites a wide interest. I seek, not to satisfy, but to stimulate this interest, and to enlist more observers, particularly among those whose opportunities permit of continuous and systematic observations. Most to be desired are observations from on board ship, in deep water far from land, but observations from the sea shore would also be welcome, and those from lightships and lighthouses exposed to the waves would be distinctly valuable.

Observations of the large waves which disturb the surface without affecting the bottom of the deep sea can only be made from on board ship, and are extremely difficult to carry out. Not only are the phenomena more complicated than in shallow water, where some regularity of direction and of speed is imposed by the limitations of depth, but the conditions on a ship are themselves unfavourable for this class of observations. The principal things to be observed are the difference of level between crest and trough, or the height of the waves, the distance from crest to crest, or the wave length, and the rate at which the crests or ridges travel, the velocity of the wave, and the interval of time between the arrival of the ridges, *i.e.*, the period of the wave. The height of the waves would be less difficult to determine if the ship herself did not rise and fall, or if she floated as a cork, but in practice she does neither the one nor the other, and the difference between the rise and fall of the centre of gravity of the ship and the rise and fall of the water cannot be calculated theoretically. Moreover, the observer cannot watch the waves from the centre of gravity of the ship, but has to station himself where the level of his eye is also continually being altered by the rolling, and sometimes by pitching. The eye under these conditions loses its power of judging horizontality owing to the sudden tilts which change the apparent direction of gravity. The length between succeeding ridges is less difficult to observe, for the known dimensions of the ship give a ready means of measurement; or a buoy can be towed astern at the end of a line of known length. Frequently the length from ridge to ridge varies greatly (sometimes in the proportion of 1 to 2, or even 3) for succeeding ridges. We have in such cases to do with more than one set of waves, for the length should vary very slightly for succeeding waves of a single set; the observed distances from ridge to ridge are, therefore, frequently, not wave lengths at all in the physical sense, but casual intervals, the dimensions of which do not enable us to calculate the velocity of the ridges by means of the theory of waves. The velocities of the ridges must, therefore, be directly measured, which can be done by timing the passage of a wave from bow to stern or from stern to bow, making the necessary allowance for the speed of the ship and the angle between her course and that of the waves. An accurate determination even of the time of passing the length of the vessel is not easy for a single observer, and the want of concordance between the ship's course and that of the wave often makes accurate measurements of velocity impossible. The best plan no doubt would be to stop the ship, but as traffic becomes more and more concentrated in big, fast vessels, the difficulty of making the necessary arrangements is correspondingly increased. In the case of the liners by which most of us now travel, the waves made by the ship herself interfere with the observation of any but large waves.

The finest attempt yet made to carry out systematic observations of waves at sea was that of the late Lieutenant Paris, of the French Navy; a pretty full account of whose work follows, condensed from the original paper in the *Revue Maritime et Coloniale*, Vol. XXXI., 1871, a publication little known to the majority of scientific men in England, and not very easy of access. Next, for comparison, I give a shorter account of the

observations made on the French ship *Astrolabe*, from the original paper in the *Comptes Rendus* of the Paris Academy of Science; and, thirdly, a summary of an important paper in the *Philosophical Magazine*, for April, 1888, in which the Hon. Ralph Abercromby described his attempts to impart a higher degree of accuracy to wave measurement. After these summaries of important papers I shall resume a more general treatment of the subject. Lieutenant Paris' observations of waves were conducted on board the *Dupleix* and *Minèrve* during the years 1867-70 in the Atlantic, Indian, and Pacific oceans, and in the Japan and China seas. Observations were made in the open sea on 205 days. Of these 29 were days on which the sea was practically smooth. On the remaining 176 days the heights of the waves were measured, but the determinations of wave length and velocity were only made in 109 days, there being 67 days during which the divergence between the ship's course and that of the waves prevented accurate observation of length and speed. When the divergence exceeded 45 degrees observation was useless. About 4000 waves in all were measured. The speed was obtained by recording, with a watch having a seconds' hand, the time the wave crest took to traverse the length of the ship, and applying the necessary correction for the speed of the vessel. The interval of time between the arrival of succeeding wave crests was also taken, and this, combined with the determination of speed, gives the wave length or distance from crest to crest. We have then determined by actual observation the speed, periodic time, and length of the waves without having recourse to the theoretical calculation of one or two of these values from the observed value of the other. This is rather important, because without a more elaborate investigation than is usually given we cannot be certain that we are dealing with a single series of waves, and the ordinary formula of reduction from period to length, from speed to length, and from period to speed, is based on this assumption. The values which Lieutenant Paris endeavoured to obtain were not so much the dimensions of single waves as the average dimensions of a number of waves passing the ship during a selected time of observation on each day. The occasion chosen for observation appears to have been not a fixed time of the day, but one selected for the state of the sea, the object being to secure as far as possible that the waves should have grown to their maximum dimensions under the breeze. The recorded speed or length of waves for any one day is the mean of at least 10, sometimes as many as 50 waves, and each of these means is treated as a single measurement. When for instance we find recorded that the maximum wave length observed in the Southern Indian Ocean was 235 mètres (771 feet), this implies that 771 feet was the greatest average wave length observed on any one day, not that it was the greatest distance which separated any two succeeding wave crests.

The height of the waves from trough to crest was estimated as follows:—The observer established himself where he could get the crest of the waves passing near the ship on a level with the horizon when he was himself above the trough of a wave. In a comparatively smooth sea the position of the observer was at one of the lower port holes, in a rough sea he would mount the shrouds. Then, says Paris, the height or amplitude of the wave is easily determined, for it is equal to that of the eye above the flotation line when the ship is on an even keel. This latter height being known, need not, he says, be determined afresh at each observation.

This assumes that the draught of the ship in the trough of the waves is constant, and equal to the draught in smooth water, which, however, is not the case. Lieut. Paris may either have overlooked the fact or may have decided to neglect the correction. There are various means of checking these measurements of waves which were applied when circumstances permitted, and when practice had been attained Lieut. Paris reckoned his measurements to be good to about 10 per cent., one-tenth part of the whole.

The strength of the wind was also recorded at the time when the waves were observed. Strictly speaking, one should know also how long this wind has been blowing, but that is hardly practicable with a ship on its course except perhaps in the Trades. The strength of the wind may be measured either by the pressure which it exerts or by its velocity. Paris chose the former method, and constructed an apparatus which measured the effective pressure of the wind upon a thin rectangular plate. In order to connect the pressures registered by the instrument with the velocity of the wind, observations were taken at favourable opportunities of the time required for light bodies tossed off from the cross-trees to fly the length of the ship. The values thus obtained for the connection between pressure and velocity are recorded in the subjoined table. The numbers in the first column of Table I. are those by

TABLE I.

Wind velocity and pressure according to Lieut. Paris.

Numbers recorded in the Log.	Verbal Description.	Velocity in Feet per Second.
0	Calme	0·0
1	Presque calme	2·63
2	Faible brise	3·87
3	Lègère brise	4·76
4	Petite brise	13·94
5	Jolie brise	34·12
6	Bonne brise	67·92
7	Vent frais	128·6
8	Vent grand frais	201·1
9	Coup de vent	354·3
10	Tempête	607·0
11	Ouragan	820·2

which the strength of the wind is usually recorded when the record depends solely on the estimate formed by the observer without use of instruments. These numbers are roughly proportioned to the square root of the velocity.

It was in the southern Indian Ocean between the Cape of Good Hope and the Isles of St. Paul and Amsterdam, in the region of almost continual westerly winds, that the largest waves were observed. On the 25th October, 1867, during a gale from the N.W., with violent snow squalls, thirty waves were measured at different times of the day which averaged 29.53 feet (9 mètres) in height. The largest of them were 37.53 feet (11 mètres) in height, and of these no fewer than six in succession were observed, which followed one another with admirable regularity. They lifted the corvette as if it had been a whaleboat, then left her wallowing in a deep trough, extending far on either hand. Paris had to mount to the 22nd rung of the shrouds before he attained the level of the crest. On the evening of the same day waves even larger were seen but not measured. Those on board the corvette seem to have agreed that the waves of this 25th October were the largest within

their experience. The height of the individual waves was often found to vary in the proportion of 1 to 2; it was only in very favourable conditions that the average height was 0.7 or 0.8 of the extreme height. In the open ocean a strong wind soon caused waves of as much as 16.4 feet (5 mètres).

The distance from crest to crest was found often to vary in the proportion of 1 to 3 in two successive waves. In a rising sea the wave length increased more rapidly than the height, a process which was found to continue for several days. Thus, to the east of the Cape of Good Hope, during strong west winds, which blew with great regularity for four days, the height of the waves only increased from 19.69 to 22.97 feet (6-7 mètres), whilst the length which was but 370.74 feet (113 mètres) on the first day had attained 771 feet (235 mètres) on the fourth. This was the greatest daily average length observed, but individual cases occurred in which more than 1312 feet (400 mètres) separated two succeeding ridges, and an interval of 984 feet (300 mètres) was not uncommon.

Much interest attaches to the determination of the ratio of the length to the height of waves. The minimum observed by Paris, for a train of waves presumably, was 13, but this was among the Kuriles in a cross sea near to land, and with strong currents running. This observation is therefore not strictly one of ocean waves. In the open ocean with a "moderate breeze" of 16.8 knots (geographical miles per hour) the length was about 25 times the height, in a gale the ratio is as low as 18, and in a labouring cross sea the ratio does not generally exceed 20. When the wind drops, the waves, of course, flatten out; when the length has become 40 times the height the condition is that of a "long swell."

The velocity, according to Paris, is the least variable element. When the breeze had been blowing steadily for some time and the sea was regular, the velocity varied but little from one wave to the next. In fact, he says, it is a rare thing in the open ocean to see two large waves pass one over another, which would be occurring every moment if there were the smallest difference in their velocities. We shall see later on that another good observer, the Hon. Ralph Abercromby, had quite different experiences on this point. In the open ocean, sufficient depth is pre-supposed; Paris finds from his daily record that a wind of the same force gives everywhere almost the same velocity of wave. He does not consider himself to be "*au large*," unless he is at a distance from the windward shore of at least twenty leagues; only then, he says, can the waves attain their full development.

The following observations were made upon the persistence of the swell after the cessation of wind. Having left the strong breezes or gales from the S.W. on October 31st, 1867, for the calm of the tropic of Capricorn, the ship, now under steam, was accompanied for three days by a swell unruffled by the slightest breath of wind. The S.W. winds had raised regular waves 14.77 feet (4.5 mètres) high, and 469 feet (143 mètres) average length, with a velocity of about 30 knots; sixty hours later, the distance traversed being 350 miles, the velocity of the wave had only diminished 2 per cent., about 0.6 knot, the wave length being 443 feet (135 mètres). The difference between the lengths of successive waves seems to have remained large. During this period the height of the waves had diminished by one half. Such a swell, if there be a sufficient stretch of open sea, would finally become invisible owing to this flattening out of the wave, for waves are only seen by difference of illumination of their front and back, but in this particular case the observer lost sight of the swell long before it was flattened to this extent owing to another cause. During the last (third) day, calm still continuing, it was crossed by a set of waves coming from the east. These were 3.28 feet (1 mètre) in height, and 174 feet (53 mètres) in wave length, about the same length as those met with afterwards when the ship entered the easterly trade winds. Here the south-westerly swell ceased to be visible, after having been traced for 150 leagues. The smaller swell from the trades was met with 50 leagues from the place where the easterly winds were blowing.

(To be continued.)

MONKEY HAND-PRINTS.

By R. LYDEKKER.

THE arrangement of the fine ridges and grooves on the palmar aspect of the human hand has of late years been studied with great attention—first by Mr. Francis Galton, and subsequently by Mr. Henry, of the Bengal Police—in order to develop a satisfactory system of identification by means of "finger-prints." To that exceedingly important and interesting subject I shall devote a special article on a future occasion. In the present communication I desire, however, to draw attention to the arrangement of these lines on the hands of monkeys, and their function in both men and monkeys. This study seems to have been first seriously taken up by Dr. D. Hepburn, of Dublin, who communicated to the Dublin Society the results of his investigations, which were duly published in the *Transactions* of that Society. The method employed by Dr. Hepburn was to take impressions of the hands of living monkeys on plates of glass coated with printers' ink; but there are many difficulties connected with this operation, and in preparing a series of impressions for the Natural History Museum, it occurred to me that I might be able to take them on paper from the hands of monkeys recently deceased. I accordingly communicated with my friend, Mr. F. E. Beddard, the Prosector to the Zoological Society, asking him to be good enough to send me the right hands of some of the monkeys that died in the Society's menagerie. With this request he very kindly complied, and from the specimens which from time to time arrived at the Museum, I was enabled to take, among others, the impressions herewith reproduced. Although they are not quite so successful as might be desired, they are yet amply sufficient to show the general plan of arrangement of their lines, and the variation to which they are subject in different genera. Enlargements from these same impressions are now exhibited in the British (Natural History) Museum.

Before proceeding further I must disclaim any intention of poaching on the preserves of the so-called science of "palmistry." This, so far as I can understand its methods, deals exclusively with the folds or creases on the human palm (corresponding with the white lines in the annexed figures), while attention is here concentrated on the mode of arrangement of the raised ridges and their intervening grooves. It may, however, be mentioned that the creases in question have, both in man and monkeys, a definite mode of arrangement, which appears to be due to the position and action of the palmar muscles. What possible connection there can be between such muscular creases and the duration of human life or the vicissitudes of our mortal career may

well be left for the professors of palmistry to explain as best they can!

As regards the structure of the palmar ridges, an examination of the reader's own hand with a lens will easily show that these consist of a series of very minute cone-like elevations, placed close together, and on the summits of which are situated the apertures of the sudoriferous or sweat glands. If a section of the skin

FIG. 1.—Right Palmar Imprint of a Macaque Monkey (*Macacus cynomolgus*); *a*, *b*, *c*, interdigital eminences; *d*, radial eminence; *e*, ulnar eminence.

be examined under a microscope, it will also be evident that within these papillæ are certain organs of touch known as the tactile bodies. Between the papillary ridges, as we may now term them, are situated the equally narrow grooves, which contain neither sweat-glands nor tactile bodies.

Looking carefully at Fig. 1, and, if necessary, employing the aid of a lens, it will be seen that the arrangement of the ridges and grooves, instead of being uniform over the entire palm, takes the shape of a series of definite patterns in certain areas, between which a more or less regular linear arrangement obtains. On the ball of each finger and the thumb, for example, it will be noticed that the ridges assume what may be termed a concentric pattern, in which the central ridges run longitudinally. Again, on the three eminences situated on the palm opposite the clefts between the four fingers, they take the form of concentric whorls (*a*, *b*, *c*). A similar radial eminence (*d*) with a whorl-like pattern is situated opposite the cleft between the thumb and the fore-finger; while yet another whorl-bearing elevation (*e*), which may be termed the ulnar eminence, has its position at the basal angle of the palm opposite the little finger. Minor eminences, with much less distinct patterns, also occur on the palmar surfaces of the two basal joints of the fingers. Between these various pattern-bearing eminences, as is especially well shown on the fingers, the ridges and grooves tend to arrange themselves either in transverse lines, or (in the words of Dr. Hepburn) with such slight modification of this direction as would place them parallel to the long axis of any cylindrical object which might be grasped by the foot. It may be added that although in the human hand the patterns found on the balls of the fingers are frequently more complex than those in the monkey's hand, yet the converse of this is true with regard to the eminences on the palm itself, the ulnar whorl being generally quite obsolete in man.

In ordinary five-fingered monkeys, whether they hail from the Old World or from the New, the foregoing type of eminences is very constant. This is well exemplified by the impression of the hand of one of the South American Capuchin monkeys (Fig. 2). Here, however,

FIG. 2.—Right Palmar Impression of a Capuchin Monkey (*Cebus hypoleucus*).

FIG. 3.—Right Palmar Imprint of a Marmoset (*Hapole jacchus*).

the fingers are much longer and more slender than in the Old World macaque. In consequence of this the bulbs of the fingers are much less developed, so that it was found impossible to get a good impression of them. These features are even more developed in the hand of the tiny American marmosets (Fig. 3), in which the digits are more like claws than fingers, and consequently afford only a narrow and blurred impression. A peculiarity of the marmoset hand-print is to be found in the circumstance that the radial eminence has come up to form an arch with the three interdigital elevations, and that the ulnar elevation and pattern are obsolete. Seeing how comparatively wide apart from one another (both zoologically and geographically) are the ordinary monkeys of the Old and New Worlds, it is not a little remarkable that the palm-print of the macaque should be so strikingly like that of the capuchin.

This similarity (since everything in nature has a use) suggests that the patterns on the hands of these two monkeys are due to the same physiological cause; and we have now to enquire what that cause is. The best clue to the problem seems to be afforded, somewhat strangely, by the tails of such of the South American monkeys as are endowed with prehensile power in those appendages. Confirmatory evidence being likewise afforded by the prehensile tails of the American opossums and tree-porcupines, as well as by those of the Australian phalangers. In all these animals the naked, grasping portion of the tail, which is situated at the extremity, is covered with papillary ridges and grooves precisely similar to those on the hands and feet of monkeys, but invariably arranged in simple transverse lines across the tail, so that in the act of grasping they would be parallel to the long axis of the branch around which the tail was coiled. Clearly, then, papillary ridges are primarily connected with the grasping power, and when they are intended solely for that function

they are so arranged as to be parallel to the axis of the object grasped. As regards this function of the papillary ridges, Dr. Hepburn observes that although they are comparatively low, "yet they must cause a certain amount of friction, and thereby prevent slipping, while the naturally moist and clammy condition of the palm and sole of monkeys must be of material assistance to the firmness of the grasp. A man instinctively moistens the palms of his hands when he wishes to make his grasp more secure; and the grasping power of monkeys must be considerably increased by the application of numerous papillary ridges which are capable of intimate adaptation to the surface of the object grasped."

In a later passage the same observer adds that, apart from the hook-like manner in which the orang-utan and the American spider-monkeys employ their hands in trapeze-like movements, there can be no doubt that the palms are capable of a considerable amount of lateral folding, as is proved by the creases to which allusion has been already made. And it appears probable that the papillary ridges are designed to afford increased firmness of grasp when the palms are thus folded. Consequently, simple transverse ridges on the palms, except in the second joints of the fingers, are conspicuous by their absence; and we find instead the complicated patterns on the eminences already described.

A somewhat different type of arrangement obtains in the hand of the South American spider-monkeys, in which the thumb is wanting. In this group it will be noticed (Fig. 4) that although whorl-like patterns

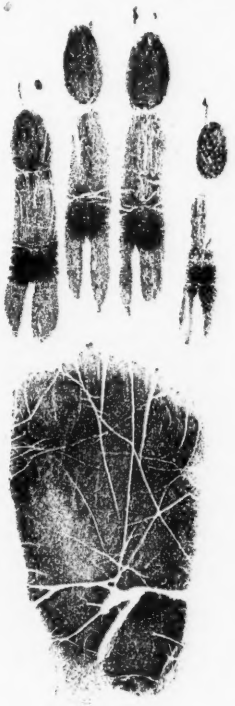

FIG. 4.—Right Palmar Impression of a Spider Monkey *(Ateles ater)*.

are observable in the interdigital eminences, yet they are much smaller and less distinct than in ordinary monkeys; the same being the case with the ulnar eminence. The radial pattern, at the inner side of the thumb is, however, practically wanting, owing doubtless to the absence of that digit. It will further be noticed from an examination of the figure that elsewhere on the palm, not even excepting the fingers, the general arrangement of the ridges is longitudinal. Since the hands of the spider-monkeys are, as already mentioned, largely used in a hook-like manner during the arboreal evolutions of these active creatures, it would seem at first sight that the arrangement of the ridges precisely controverts what has been said above as to their being parallel with the long axis of the object grasped. But the palms of even these monkeys, as is indicated by the numerous creases, are evidently much folded laterally; and it must also be borne in mind that an equally important function of the hand is the plucking and holding of spherical or sub-spherical fruits. And for such a combination of functions the mode of arrangement of the ridges is doubtless the one that is most suitable. If the ridges were transverse the fruit would very probably have a tendency to slip out of the hand on one side of the other; but this is clearly prevented by the longitudinal arrangement.

The above are the chief modifications displayed by the palm-prints of monkeys; and it may be added that a very similar general plan of arrangement of the papillary ridges and grooves obtains on the sole of the foot of these animals, subject, however, to such modification as is necessary for the different function of the foot as compared with the hand. But in some at least of their allies, the lemuroids, as represented by the true lemurs of Madagascar, the galagos and pottos of Africa, and the lorises and tarsier of Asia, a very curious departure from this arrangement obtains. In regard to the true lemurs it is generally stated that on the outside of the palm of the hand and under the base of the fingers are situated fleshy pads, giving them greater grasping power. This, however, is scarcely an adequate statement of the true state of the case. Fig. 5 shows

FIG. 5.—Right Palm-print of Red-fronted Lemur *(Lemur rufifrons.)*

the palm-impression of the red-fronted lemur, a well-known Malagasy species. In this it will be seen that the balls of the digits are expanded into large convex circular pads upon which are a number of papillary ridges; but instead of these ridges covering the whole surface of the pads, they are interrupted by an irregular net-work of relatively large canals, producing the white lines in the impression. On the palm of the hand are seen the three interdigital eminences of the monkey's hand, together with a large radial and a somewhat

smaller ulnar eminence. The radial eminence is, however, divided into two portions by a deep groove, and on all five eminences are observable the usual papillary ridges and grooves traversed by the aforesaid irregular network of grooves. On the palmar aspect of the second joint of the fingers, and on such portion of the centre of the palm as exhibits an impression, the papillary ridges, instead of being uniformly distributed in regular lines, are restricted to certain small pustule-like eminences, on which, however, the linear arrangement is distinctly visible with the aid of a lens. And if it had been possible to obtain an impression of the basal joints of the fingers, a similar pattern would doubtless have been noticeable there also. Whether the curious arrangement of canals characteristic of the palm of the red-fronted lemur, or a modification thereof, obtains in all the true lemurs, must await the acquisition of additional fresh specimens of the hand; but in that species at all events it seems certain that these pads must have a kind of sucker-like action, which greatly increases the firmness of their owner's hold on the boughs it grasps.

Apparently this type of palm-structure culminates in the curious little tarsier of the Malay Islands, in which the long and slender toes terminate in round sucker-like disks; similar disks occurring on the toes of the hind-foot. Unfortunately I have had no opportunity of taking the palm-impression of a recently deceased tarsier, and it will probably be long before such a chance occurs, so that I can say nothing as to the mode of arrangement of the papillary ridges.

It may be added that the finger and toe-pads of those curious lizards commonly known as geckos are likewise modified into adhesive disks. But in this case the sucking action is caused by the skin being raised into a series of parallel plates, and as palmar eminences, as well as papillary ridges, are wanting, the structure is not apparently strictly comparable with what obtains in the tarsier and the lemurs.

But even the foregoing by no means exhausts the subject of palmar and plantar eminences. Anyone of my readers who takes the trouble to examine the feet of a cat, a dog, or a rabbit will find a number of bare elevated pads, covered with rough granular skin, interspersed among the generally hairy surface. In all cases, both in the fore and hind limb, one of these bare pads will be found occupying the lower surface of the terminal joint of each toe, lying immediately below the claw. And it will be quite obvious that these correspond to the pattern-bearing eminences occupying the balls of the thumb and fingers of the monkey. In regard to the pads on the palm and sole, these are subject to some degree of variation in the carnivora, and they may sometimes coalesce to such a degree that their original relations are more or less obscured. But in some of these animals* three distinct pads are observable in the fore-foot corresponding in position with the interdigital eminences of the monkey's palm. Continuing the semicircle formed by these three is a fourth pad, representing the radial eminence of the monkey, while further down on the palm is one corresponding to the ulnar eminence of the latter; a small additional pad being intercalated between the radial and ulnar.

It is thus fully demonstrated that the pads on the fore-foot of the dog and the cat correspond with the pattern-bearing eminences of the monkey's palm, and these again with the much less distinctly defined eminences on the human hand. In animals which use both feet exclusively for walking, it will, however, be obvious that delicate papillary ridges, designed partly for the purpose of obtaining a firm grip of any object seized, and partly to act as organs of touch, would be perfectly useless. And we accordingly find the papillary ridges of man and monkeys replaced in the cat, the dog, and the rabbit by granular conical elevations, which have, however, doubtless the same structure, and which are foreshadowed by the pustules on the finger and palm of the lemurs.

One other point remains to be mentioned. In all the lower monkeys that have been examined both by Dr. Hepburn and myself the pattern of the papillary ridges is of the concentric type (as shown in Fig. 1), in which the central ridges are longitudinal and the external ones form broad ellipses. In the chimpanzee, however, and probably also in some or all of the other man-like apes, the pattern on the balls of the fingers is of the form known as the looped type, which is of common occurrence in the fingers of the human hand. On the finger-tips of man alone occurs the still more complicated whorled type. The explanation of the characters of these two latter types may be reserved for an article devoted to human finger-prints; and it will accordingly suffice on this occasion to record the fact that even in such a minute detail as the arrangement of the lines on the fingers of the man-like apes and man stand apart from their kindred, and that in man alone is the most complicated type ever developed, although even in him it is comparatively rare.

* Those who are interested in the subject may turn to the figure of the foot-pads of the linsang, given by the late Professor Mivart on page 158 of the *Proceedings* of the Zoological Society for the year 1882.

PHOTOGRAPHY "IN NATURAL COLOURS," BY THE McDONOUGH-JOLY PROCESS.

By H. SNOWDEN WARD, F.R.P.S., Editor of *The Photogram*.

IN the present state of scientific knowledge, and in writing for the readers of KNOWLEDGE itself, it is unnecessary to say anything about the general history of attempts to solve the problem of "photography in the colours of nature." It may be well, however, to briefly outline the history of the process now known as the McDonough-Joly, and perhaps, even before beginning the history, to explain why I write of an old process at this particular time. The reason is that this process has only just reached the point of thorough practicability, and that in a few months it ought to be possible for every photographer to obtain, at a very small cost, the necessary apparatus and materials.

I have no brief on behalf of this particular process, and I realise the great beauty and value—if you will, the *superior* beauty and value—of the results of the triple-film superposition process. The two methods supplement rather than antagonise each other, and each has its advantages. Those claimed for the McDonough-Joly process are that it requires the smallest possible alteration of existing apparatus, no change in existing methods, and necessitates only one exposure, with one lens, on one plate, to secure the triple colour-record. Further, from the negative so made, a single transparency can be prepared (in the same way as making an ordinary lantern-slide) for lantern projection, and a single printing by well-known processes will give a colour-print on paper. To project the transparency in colours, a colour-screen is necessary, and to make the print in colour it is necessary that the photographic sensitive surface shall have been laid by the manufac-

turer of the paper on a substratum ruled with alternate lines of red, green and blue, as will be explained later.

The history of the process is interesting and even romantic; for one of the early workers, a most fertile inventor, broke down entirely under the mental strain of his work, while another, James McDonough, wrecked his constitution by close and ceaseless application to research, and died within a day or two of the making of the first successful negatives by his process. The first published particulars of the process were given in a little book ("Les Couleurs en Photographie: Paris, Marion") issued in 1869, and written by Louis Ducos du Hauron, who had previously made communications on various modifications of a triple process of colour photography suggested by himself, on January 20th, 1859, before the Society of Arts and Sciences of Agen. This particular method was allowed to lie unused and undeveloped, and nothing more was heard of it until 1894, when it was patented, almost simultaneously, in Britain and America, by Dr. John Joly, of Dublin, and Mr. James McDonough, of Chicago. Both these workers seem to have devised the method independently, and without knowledge of the work of du Hauron.

The process is based upon the well-known triple negative process, in which, by means of plates sensitive to the various colours of light, and by the use of light-filters of coloured glass or coloured solutions, negatives are made separately of each of the primary colour-sensation effects. By the superposition of prints in corresponding coloured inks or pigments from each of these negatives, natural-colour prints may be made upon paper, as in the well-known process of trichromatic letterpress printing. Similarly, the superposition of three transparencies or positives in stained gelatine, gives us a natural colour transparency or lantern-slide.

In the McDonough-Joly process, the three negatives are made upon one plate by the simple expedient of replacing the three successive light-filters by a "screen" ruled with fine lines of transparent stained gelatine in successive rulings of red, green, blue, red, green, blue. Each of these lines is $\frac{1}{300}$ of an inch in width, and they are ruled so as to touch, edge to edge, thus entirely covering the glass of the screen. These ruled lines are pressed into contact with the sensitive dry-plate during the exposure in the camera, with the result that the negative so made consists of lines of silver deposited under the lines of the screen. Thus, supposing a blue object, reflecting light of exactly the colour of the blue line of the screen, was photographed, the negative would show two lines of clear glass (under the red and green) while under every blue line the silver would be strongly deposited. Thus, every third line may be considered as part of a distinct negative, recording one of the three primary colour sensations. Where an object reflects light of a composite colour, both the colours that go to make up the composite will be affected. Thus, if the object is yellow, it will be represented under both the red and the green lines.

From the colour-effect negative, which looks just like any ordinary negative except for the fine lines, a transparency may be made by exposing a sensitive plate in contact, and developing in the same way as in making an ordinary lantern-slide. This is, of course, a reverse of the negative, so that in the suppositious case of the blue object the transparency would show silver deposit in parts corresponding to the red and green lines, with clear spaces corresponding to the blue. To view the picture this positive transparency is placed in contact with a lined colour-screen somewhat similar to the one used in making the original exposure. Looking through the combined transparency and screen, one sees that the silver deposit in the transparency obscures the red and green, allowing the blue to be plainly seen.

The same sort of thing happens with photographic prints on paper. The raw paper is first ruled with the fine red, green, and blue lines, after which it is coated (say) with a sensitive gelatino-chloride emulsion, thus converting it into P.O.P. or print-out paper. The negative is placed upon a sheet of this, taking care to register the lines of the negative exactly over their proper colour-lines on the paper. The printing causes the parts of the paper to which the light has access to become dark-brown with the opaque reduced silver—as under those lines of the negative which are transparent, because the light from the original object has not acted upon them. The photographic image forms a stencil or mask to the coloured lines, just as it did with the positive transparency.

In photo-mechanical printing, a metal printing-block takes the place of the negative, and a dense printing-ink (black or a neutral grey) replaces the silver deposit.

The lines, when ruled three hundred to the inch, are so fine that, viewing a picture as a whole, from any reasonable distance, they are quite inoffensive.

Intermediate colours, made by the reflection of varying proportions of the primaries from lines so fine that the eye does not separate them, are purer and better than those made by transmission of the light through three superposed films—always supposing, which is not at present the case, that the original colours are equally good and pure in each instance. On the other hand, the dark "stencil" image, occupying a large proportion of the space, tends to lower the tones throughout the picture; except in the case of a transparency with ample illumination.

Many difficulties which beset the process, and which rendered it practically impossible when first suggested, have been removed in the general progress of photography, without any effort on the part of those interested in the process itself. These difficulties chiefly related to the obtaining of plates sensitive enough to the red rays of light to render short exposures possible; and plates which should be fairly sensitive to the whole range of the spectrum. The great attention given to orthochromatic photography has led to the production of such plates, and immensely helped all natural colour investigators.

The difficulties peculiar to the McDonough-Joly process are chiefly connected with the manufacture of the colour-screen. The problem was to rule screens that should be cheap, transparent, permanent in colour, fine enough to prevent the lines being offensive, yet coarse enough to make registration on viewing screens or on ruled paper, sufficiently easy. The people interested in developing the process, headed by Mr. D. K. Tripp, of Chicago, have decided upon the standard gauge of three hundred lines to the inch, and as the result of a few weeks' working with negatives and transparencies on that scale I conclude that it is a very practical arrangement. As to the permanency of the screens, I have some of Dr. Joly's make, which seem to show no deterioration in a couple of years or so; and I am informed that some of Mr. McDonough's have been exposed for about five years without apparent change.

The question of price is, of course, most important, for if every transparency is to have its separate viewing-screen the screens need to be cheap. At present, the demand for screens can not be supplied at any price, because only the experimental ruling machinery is

available, and its capacity is very small, but Mr. Tripp informs me that as soon as machinery now building is completed it will be possible to supply viewing screens of the American standard lantern-slide size (4 in. × 3¼ in.) at $2 a dozen, or say, eightpence each; and that in the course of a couple of years it should be possible to make them for one or two shillings a dozen. As for the ruled paper, since prints made upon it, photo-mechanically, can compete in price with prints by the trichromatic process, the ruling itself must be done very cheaply, and there is no apparent reason why paper ruled from the reel, and printed with registering marks to correspond with similar marks on the camera screen, should not be supplied to the photographic paper-makers at a price that will add but little to the price of their product.

As regards the transparencies and prints made by this process, one must admit that their "truth to nature" is dependent upon care in the photographing. Exposure, development, and printing offer as great a field for the personal influence in this, as in the ordinary monochrome methods of photography. While one man will represent nature in the brilliant hues of a modern French water-colour or chromo, another will give us the same scene lost in the brown-varnish gloom of an oil-painting by an old master. The scientific man who wants bold accuracy can secure it; while he who has the artist's fancy and imagination can let them wander at will in fields of colour, just as he now attempts to satisfy them with variations of tone and texture.

BIRD-LOVE IN WINTER.

By CHARLES A. WITCHELL.

ALTHOUGH the season of nidification is the time when birds seem the most erotic, there is no little evidence that a degree of mutual affection between birds of opposite sex often exists at other periods of the year. Much of this evidence is perhaps hardly within the scope of scientific proof; but some of it, on the other hand, is strongly suggestive of at least a kindly interest, though this be indicated only by couples of birds separating themselves from others in the same assemblage or company. Among the more solitary common species the same nest-places, dormitories, and general habitats are usually tenanted by what seem to be the same respective pairs of birds. The crow, magpie, and kestrel are familiar instances. It is clear that in these cases there is at least no ill-will existent between the birds of a pair; they seem not to bicker and snap at each other; nor to derive satisfaction from each other's misfortunes; but to desire each the presence of the other, and to be content in it. Selective companionship, therefore, is our first piece of evidence; and it is given, not only by the solitary birds, but also by some of the gregarious kinds. Why do the jackdaws and rooks in evening flight to the great roost-place so often fly in couples, even as early as September, unless it be that they have begun to select their mates for the next year? They do not behave thus on every evening, for when the wind is high, or they are flying down-wind, the couples are broken, if, indeed, ever formed. But on a still autumnal evening, when the birds are not seeking food nor avoiding enemies, but merely passing onward to the accustomed resort, four-fifths of them, at least, fly in couples. The jackdaws are the more restless, some of the couples being disturbed by one or more erratic and noisy members of the troop; but most of them, like the more staid rooks, seem to prefer to have one only near them. Although at first sight the statement may seem hardly credible, I have noticed similar behaviour in small groups of starlings flying to roost. When living at Eltham I had constant opportunities of observing this, for at evening immense numbers of starlings assembled in the near thickets, and I was often surprised to notice, even in autumn, how many birds in the small clusters had distinctly tended to arrange themselves in couples, though the preference only attained to the lessening of the average distance in the flock, to the extent of a few feet, between the particular birds. In the case of the rook and jackdaw the young birds of the year seem to demonstrate this selective association as freely as the old birds, but the natural tendencies of starlings in this respect are less discernible, for the latter birds are much the more timid of aerial enemies—and justly so. The sight of a sparrow-hawk will break up their formation in a moment, and send the scattered detachments streaming wildly about the sky, or scurrying low among the tree-tops.

Friendly hawks not only tolerate each other's presence in autumn and winter, but sometimes indulge in bye-play suggestive of at least a kindly interest in each other. In October last, one breezy day on the Cotteswolds, a male and female kestrel came into view flying lazily. They soared and drifted somewhat, and then swooped at each other more than once, obviously in play; and then drifted on as before. At the end of November I was watching a pretty male kestrel searching a hillside. Presently across the valley came another kestrel, a female bird, going directly towards him. She passed in full view, and it was noticeable that she was not flying quite in the usual way, but with very rapid and ceaseless beat of wing, and yet not travelling at a great pace. She did not alter or stay her course; but the other did not seem to fear her at all, and let her stoop full at him, as though he knew she would not hurt him. As a fact, she seemed to lessen her speed when approaching him; for she spread her wings, and swung at him like that; and both birds soon afterwards settled in a tree. It seemed that by this mode of approach she was showing a kindly interest in her mate—six months before nesting-time. Her flight reminded me of that of an amorous lark or chaffinch.

The call-notes and songs naturally afford much stronger evidence than what is above written, of the existence of winter-love in birds. So far back as September, the robin was in full song; and, although he always sang before fighting another singer, still there was often near him a robin which did not sing, and which he did not attack, but to which, very possibly, some of the songs may have been addressed, for, at that season, the call-note of the singer was heard almost as often as it is in early spring. Throughout the cold season the presence of that silent robin is tolerated by the singer, though the vocal rival is persistently attacked. The starling has love-notes in his song all the winter.

The wren, another autumn singer, makes great use of its call-note at the time of the falling leaf. In a garden is a wren's nest, I know, which has been in existence for two years. Eggs have never been laid in it, and in summer the presence of spiders' webs across the opening indicates that the tenement is then unoccupied; but in winter the webs are not there, and a wren may be seen going in and out. In November, in a tree close to the nest, were two wrens, about a foot apart; the one, with head raised, was obviously addressing the other with continuous call-notes. One would have required

to shoot the birds to establish their sexual identification, but without that one might fairly assume that here was an instance of winter-love. A few days later, in another district, I saw two wrens behaving in a precisely similar manner. The incident is, indeed, a common one.

In autumn the hedge sparrows seem to be choosing mates for the winter and next year, for we see a silent and timid one pursued by one or more twittering and fluttering others, and are able easily to recognise a study in the art of love, as the gentler birds understand it. At that time the male house sparrows have recommenced their mobbing of their much-worried female relations, and throughout the winter pairs of this species sleep in accustomed shelters. The great titmouse seems to have selected his mate before Christmas, at which time the birds are generally travelling in couples, though often two couples are in the same resort. This is in keeping with the resumption of the bird's clinking song-note in autumn. Nuthatches likewise are generally found in couples, before the cold weather has commenced, and, throughout it, owls may be heard hooting and calling.

Although the finches and allied birds do not generally sing in the cold, one cannot say that attachments between the sexes do not then exist—except, perhaps, in the case of the bachelor chaffinch. The male bullfinch is generally accompanied by his mate, and if either is disturbed it does not retreat without calling the other. Even the greenfinch, gregarious as he is in winter, seems sometimes then to travel in couples. In the severe winter of 1894-5 I killed some fifty greenfinches in a garden, to supply the larder of a kestrel which seemed to be worth the sacrifice; and I soon noticed that the successive finches appeared in pairs, or in small groups of even number. Only once or twice was an odd number of them there. The attraction was some loose straw, and the trap a spring-net, which could be released as desired. Directly after a pair of the birds had met their fate another pair appeared, and finally a couple nested in the garden, as usual.

At the moment of writing (early in December) I have been watching the amorous antics of four couples of jackdaws, each couple keeping aloof from the others, though all were in the same spot. Most of them were garrulous as usual; and, in flight, a leading bird would sometimes descend on drooped wings, uttering meanwhile the long rough "carr," which seems to be the love-note of the species. But two of them, perched high in an elm, were actually preening or pecking each other's feathers in a gentle manner. I have never before seen other birds than pigeons do this, and then only at nesting-time, but through a telescope (×11 dia.) the movements of the birds were clearly visible.

The rook, however, seems to furnish the strongest instance of affection in the dead season. My brother, Mr. E. N. Witchell, who sometimes resides near Minchinhampton Down, has often in winter seen one of the rooks which abound there take to another some morsel of food. Quite recently he saw a rook take up something, hop away to another rook, and give up the prize, which the receiver ate. The rook has as good an appetite as any other bird, and such an instance as this is proof of a bond between the birds higher than mere mutual association for detecting danger, or preferential companionship. Many of us are seemingly too ready to estimate bird-love at the level of the poultry-yard, or at any rate to consider it as incidental to springtime only. In several species this estimate seems to be supported by fact; but in others "love" seems to be of a more enduring and a nobler kind.

NOTES

ASTRONOMICAL.—From spectroscopic observations, Mr. Newall has found that the velocity of α Persei is variable, with a period of possibly four or sixteen days. Presumably, therefore, this is another star which has a relatively dark companion. Such systems, as pointed out by Prof. Campbell some time ago, are probably at least as plentiful as visual binaries.

A special interest attaches to the spectroscopic binary Capella, independently discovered by Mr. Newall and Prof. Campbell, for the reason that the companion is sufficiently luminous to show a spectrum, and the computations suggested that the components might be separated visually in a powerful telescope. With the 28-inch refractor at Greenwich, an "elongation" of the star, amounting to at least a tenth of a second, has been observed, in accordance with the spectroscopic observations, but Prof. Hussey, observing with powers up to 2600 on the Lick refractor, has failed to find either elongation or separation.

As a result of measurements of one of the charts already published in heliogravure by the French observatories taking part in the International Astrographic Chart of the Heavens, Prof. Turner considers it probable that they yield star places at least as good as those obtained with meridian instruments. It appears, however, that the complete results, if produced in the same careful manner, would cost each of the eighteen participating observatories no less than £10,000.

M. Deslandres, of Meudon, believes that he has succeeded in registering, by means of the infra-red rays, the general form of the solar corona without an eclipse. The eclipse results on which his method is based, however, appear to be at variance with those obtained by Prof. Langley.—A. F.

BOTANICAL.—A caoutchouc-producing plant, which gives promise of thriving under cultivation, unprotected, in a temperate climate, is now, according to the *Revue des Cultures Coloniales*, engaging the attention of the officers of the Jardin Colonial at Vincennes, near Paris. This plant, *Eucommia ulmoides*, has been for some time an object of considerable interest to botanists, an interest increased in consequence of its bark being highly esteemed by the Chinese as a tonic medicine. Its first appearance in this country, about ten years ago, was due to Dr. A. Henry, who sent specimens from Hupeh, China. Shortly after it was described and figured in *Hooker's Icones Plantarum*. An elastic gum-like substance, abundantly present in almost every part of the plant, formed the subject of an important paper by Professor Weiss in the *Transactions of the Linnean Society*. The French propose to introduce the *Eucommia* into Anam, Tonquin, and their colonies in North Africa.

Instances of variation from the normal opposite or whorled arrangement of the leaves in Labiatæ, excluding such as would be considered in a work on plant teratology, are exceedingly few. Their existence, however, has formed the subject of a paper, which Messrs. Burkill and Wright have contributed to the last volume of the *Journal of the Linnean Society*. About four years ago, a French botanist, M. Hua, established the genus *Icomum* on a tropical

African plant with distinctly alternate leaves. To this genus Messrs. Burkill and Wright have now added three more species, each possessing the same peculiarity of leaf arrangement. Further, they include in their paper a description of a new alternate-leaved *Plectranthus*, thus making a total of five species of African Labiatæ characterised by alternation of leaves.

The recent enumeration of Chinese oaks, published in the *Journal of the Linnean Society*, includes nearly sixty species, many of which exhibit some remarkable deviations in habit, leaves, and particularly in fruits, from the British representative of the genus. *Quercus cornea*, one of the most interesting in the structure of the acorn, is the subject of a plate in the last part of *Hooker's Icones Plantarum*. The woody involucre envelops all but the broad top of the curiously shaped acorn, to which it remains firmly attached even when the fruit is quite mature. In common with a few other East Asiatic species, the extremely hard pericarp forms ingrowths into the cell-cavity, incompletely dividing it into four or five cells, and causing the cotyledons to become lobed, as in the walnut. Its acorn, known to the Chinese as "Shi-li" (Stony Chestnut) or "King-li" (Peking Chestnut), is sold in the markets of South China as an article of food.—S. A. S.

ENTOMOLOGICAL. — Everyone knows the care for their young displayed by ants, wasps, and bees, but parental affection in beetles is not so familiar, though several instances are known to naturalists. A recent observation on this subject is due to Dr. J. E. V. Boas, who, in a paper "Ueber einen Fall von Brutpflege bei einem Bockkäfer" (*Zoolog. Jahrb.* (*Abth. f. Syst. u.s.w.*), xiii., 1900, pp. 247-257, taf. xxii.), has given an account of the operations of the willow longhorn beetle (*Saperda populnea*) when egg-laying. The female makes a horse-shoe-shaped cut in the bark of a twig, afterwards forming transverse furrows across the enclosed area. The egg is laid at the central point of the arch of the horseshoe marking. This work of the mother beetle induces a pathological condition in the wood, which leads to the formation of a gall-like growth, affording a suitable food supply for the growing grub.

Musical Beetles. — The last issued part of the *Transactions of the Entomological Society* (1900, pp. 433-452, pl. vii.) contains an interesting paper on "Stridulating Organs in Coleoptera," by Mr. C. J. Gahan. His researches confirm Darwin's observations in the "Descent of Man," that these organs are "wonderfully diversified in position," though their structure is usually simple, consisting of a series of fine striations over which a file-like area or a rasping edge, formed by some neighbouring part of the exoskeleton, plays. In many cases the striated area is divided into a coarser or finer portion, whence it appears that notes of varying pitch can be produced. The best known of "musical beetles" are probably the long-horns, which rub the movable prothorax over a striated area on the mesonotum; but stridulating organs may occur on the head, legs, wing-cases, and hind-body. It is remarkable that a similar organ may be developed in widely different families in exactly the same position on the beetle's body. Although these organs are often equally developed in both sexes, Mr. Gahan inclines to the theory of sexual selection as their probable explanation. But the presence of "musical boxes" on the grubs of beetles is much more puzzling, especially as they occur in groups that live underground (as the chafers and dor-beetles), or burrowing in wood (like the stag-beetles and passalids). In these grubs the roughened areas are on the haunches of the middle legs, and the scrapers on the hind-legs; in the passalid grubs the hind-legs are so reduced that they are useless for anything else than sound-producing. It has been suggested that "with a number of larvæ living close together in the way described, it would be an advantage to each to be left in undisturbed possession of its burrow. . . . Stridulation acting as a sort of declaration of each individual's rights would tend to promote general harmony."—G. H. C.

ZOOLOGICAL.—The discovery by Major A. Gibbons of the white, or Burchell's, rhinoceros (*R. simus*) to the north of the equator, near Lado, removes one species from the list of animals threatened with impending extermination. Previously, this animal was considered to be practically confined to the region bounded by the Zambesi and Orange Rivers. Among other African animals bordering on extinction is the mountain zebra (*Equus zebra*) of Cape Colony; it is therefore fortunate that a nearly allied form has been discovered in Angola and the adjacent districts, of which specimens have recently been sent to this country by Mr. W. Penrice.

Several of the West African mammals are of archaic types, and it is now urged by Miss A. Carlsson that the two-spotted paradoxure (*Nandinia binotata*) is nearly related to *Amphictis*, of the Oligocene of France. *Nandinia* is also peculiar in possessing a kind of rudimentary abdominal pouch, the presence of which has led one writer to suggest that the creature is a marsupial instead of a civet.

A palæontological contribution of much interest is one by Prof. H. F. Osborn in the October number of the *American Naturalist*, dealing with the question of the relationship of birds to the extinct dinosaurian reptiles. Although it is considered that many of the resemblances between these groups are due to adaptation for the upright posture, the author comes to the conclusion that birds are probably an early offshoot from the dinosaurian stock before that posture had been attained by any of its members.

It is interesting to find that, according to a paper contributed by Prof. E. Fraas to the *Fundberichte aus Schwaben*, the ancient Romans were well acquainted with the difference between the bison and the wild ox, or aurochs; characteristic statuettes of both species having been discovered. Dr. Fraas refers the bison thus represented to the extinct *Bos priscus*, although we should have thought it more likely to be identical with the living *B. bonassus*.

The worm-like *Balanoglossus* and its kindred form are one of the most interesting groups of invertebrates on account of their relationship to the vertebrates; therefore every new fact connected with them is of importance. In the *Transactions* of the New Zealand Institute for 1899, Prof. Benham records the presence of the above-named genus in New Zealand waters; while in the *Proceedings* of the Washington Academy for August Mr. W. E. Ritter describes the new genus *Harrimania* from the Alaskan coast.

For the first time in its long career the Zoological Society's menagerie in the Regent's Park has received living examples of the tenrecs (*Centetidæ*) of Madagascar, most or all of which have been received on deposit from the Hon. Walter Rothschild. The tenrecs are some of the most curious and primitive of the insectivorous mammals, and are entirely restricted to Madagascar. Their spiny covering gives them a superficial resemblance to hedgehogs, from which, however, they differ markedly in the form of their teeth, as well as in many other characters. Several specimens belong to the common tenrec (*Centetes ecaudatus*), but one indicates a different type. The former show that the stuffed specimens in museums give no adequate idea of the form of these strange animals, whose

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CLUSTERS M. 35 AND H VI. 17 GEMINORUM.

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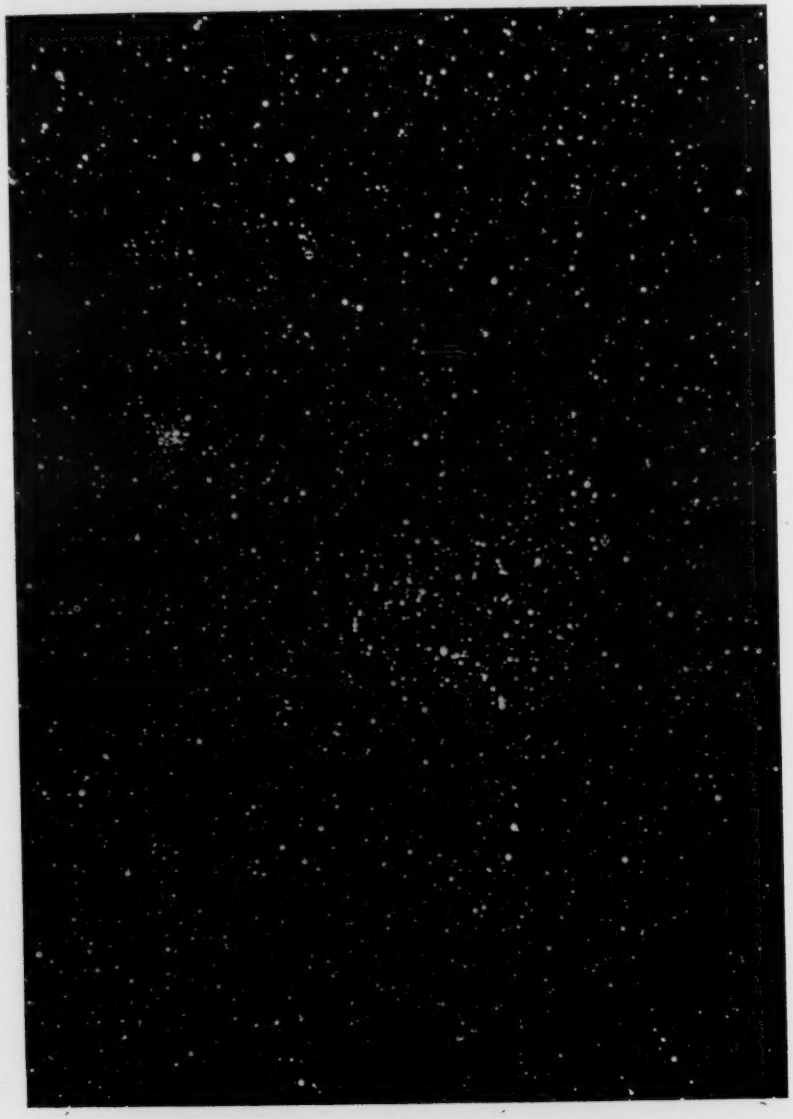

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NEBULÆ IN MONOCEROS.

By ISAAC ROBERTS, D.Sc., F.R.S.

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bodies may be compared to those of inflated globe-fish. Perhaps the most peculiar feature about them is the swollen condition of the hinder part of the palate, which is, of course, only seen when they yawn—a habit in which they seem fond of indulging.

Another animal at the "Zoo" never before exhibited alive in this country is the white goat of the Rocky Mountains, one of the few species of mammals that are white at all seasons. We purposely allude to this animal by its popular name, since naturalists are not in accord as to its proper scientific title; English writers generally calling it *Haplocerus* (or *Aplocerus*), while Americans prefer *Oreamnus*. We think the latter are in the right.

The German naturalist Hermann Klaatsch has made the interesting discovery that, with the exception of the man-like apes, none of the Old World monkeys possess a muscle corresponding with the one known in human anatomy as the short head of the *biceps flexor cruris*. And since the representative of the same muscle, under two different modifications, occurs in the American monkeys, the question whether these are more nearly related to man and the man-like apes than are the ordinary monkeys of the Old World is opened up.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.—At meetings of the council of this important undertaking held on December 12th and 13th, the object, scope, and organisation as defined by successive conferences held during the last four years were brought into their final form, and all arrangements were completed for the definitive commencement of the work on January 1. The catalogue will at first be issued in annual volumes, but its form and rate of production will necessarily be governed to a great extent by financial considerations. The responsibility for publication and for the initial expenditure is undertaken by the Royal Society, and the central bureau will be in London, while regional bureaux in correspondence therewith will of course be established in all the countries taking part in the undertaking. A comprehensive and elaborate system of classification has been devised with the assent of all the countries interested.

PHOTOGRAPHS OF THE CLUSTERS M. 35 AND H VI. 17 GEMINORUM, AND OF NEBULÆ IN MONOCEROS.

By ISAAC ROBERTS, D.SC., F.R.S.

CLUSTERS M. 35 AND H VI. 17 GEMINORUM, AND OF THE STARS AROUND THEM.

THE photograph exhibits the region in the sky between R.A. 6h. 0m. 24s. and R.A. 6h. 4m. 39s., and in declination between 23° 34′·0 and 24° 58′·3 north. The area is, therefore, 4m. 15s. in extent from *preceding* to *following*, and 1° 24′·3 from north to south.

Scale, one millimetre to thirty seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900:—

Star (.) D.M. No. 1095 Zone +23° R.A. 6h. 0m. 45·1s. Dec. N. 24° 19′·5. Mag. 8·7.
Star (..) D.M. No. 12·9 Zone +23° R.A. 6h. 2m. 4·2s. Dec. N. 23° 52′·5. Mag. 8·5.
Star (·.·) D.M. No. 1135 Zone +24° R.A. 6h. 3m. 41·2s. Dec. N. 24° 13′·3. Mag. 8·4.

REFERENCES.

N.G.C. 2168. G.C. 1360. *h* 377. Rosse, *Obs. of Neb. and Cl.*, p. 52. Lassell, *Mem. R.A.S.*, Vol. XXIII., p. 59 *I.R. Photos*, pl. 19, p. 63, H VI. 17, G.C. No. 1351.

The photograph was taken with the 20-inch reflector on January 20th, 1900, between sidereal time 4h. 12m. and 5h. 42m., with an exposure of the plate during ninety minutes; and the stars are depicted to about 17th magnitude. The cluster M. 35 is the large patch of scattered bright and faint stars on the *north following* side of the centre, and H VI. 17 is the small cluster on the *south preceding* side. Both the clusters and the stars surrounding them present to view in a striking manner numerous curves and lines of stars with void spaces between them, which enable us to view the darkness of space beyond the *Galactic* stellar universe of which the solar system forms a relatively insignificant point.

Many astronomers have tacitly adopted the assumption that the stars extend indefinitely into the expanse of space, but that the reason they cannot be seen is the absence of sufficient telescopic power to reveal the very feeble light of stars that are beyond the range limit of all existing telescopes. But the evidence obtained by the aid of photography during the past twelve years strongly indicates, if it does not demonstrate, that those vacant spaces which are visible on photographs that have been exposed to the sky during intervals of seven to twelve hours are really void of stars. This inference is based upon the fact that photographs have been taken of identically the same areas in the sky but with exposures of only ninety minutes show the same stars, including those of the faintest magnitude, that were shown on the plates exposed up to twelve hours. Therefore we are justified (by our present knowledge) in adopting the inference that no fainter stars exist, and that the universe which includes all the stars and the nebulosity of the *Milky Way* is limited in extent, and that it may be considered as a separate and distinct aggregation of stars and of material of which stars are made independently of other similar stellar aggregations which may exist in the inconceivable expanse of space beyond the *Milky Way*. This view, based as it is on credible evidence, would reduce the whole of the solar system, including the planets and satellites, to a mere speck relatively with the Galactic universe alone, and relatively with the others that may be beyond, inconceivably small—a microscopic speck. What then about the earth, which we naturally look upon as a world of great importance? Important of course it is to the million forms of life that exist upon it, ranging between the monad and the elephant, or the whale, or man, but very small relatively with the solar system and insignificant relatively with the Galactic universe.

Some minds are slowly developing and forming conceptions which in time will enable them to appreciate the grandeur of the views of nature as they are revealed to us by recent researches in astronomical and in other branches of science; but general enlightenment must necessarily be slow, for the propagation of ancient obscurantist ideas oppose and greatly retard progress in the development of reason founded upon a basis more substantial than the waking dreams of obscurantists.

NEBULÆ IN MONOCEROS.

The photograph exhibits the nebulæ and the region surrounding them between R.A. 6h. 24m. 7s. and R.A. 6h. 28m. 0s., and in declination between 9° 12′·4 and 10° 36′·1 north. The sky area represented is, therefore, 3m. 53s. in extent from *preceding* to *following*, and 1° 23′·7 from north to south.

Scale, one millimetre to thirty seconds of arc.

Co-ordinates of the fiducial stars marked with dots for the epoch 1900:—

Star (.) D.M. No. 1159 Zone 10° R.A. 6h. 25m. 39·4s. Dec. N. 10° 0′·5. Mag. 8·3.
Star (..) D.M. No. 1171 Zone 10° R.A. 6h. 27m. 18·3s. Dec. N. 10° 14′·1. Mag. 8·2
Star (·.·) D.M. No. 1172 Zone 10° R.A. 6h. 27m. 32·8s. Dec. N. 10° 23′·1. Mag. 8·7.

XUM

REFERENCES.

N.G.C. 2245-47. Index Catalogue No. 446-7.

The photograph was taken with the 20-inch reflector on March 1st, 1900, between sidereal time 6h. 28m., and 9h. 15m., with an exposure of the plate during two hours and forty-seven minutes. The star marked with two dots (..) is H IV. 3, N.G.C. No. 2245, and it is surrounded by faint nebulosity. The star marked with three dots is described as a nebulous star; and so also is the bright star, at a distance from it on the *north preceding* side, described as a nebulous star of 10th magnitude (Index Catalogue No. 446), but it is shown on the negative to be surrounded by extensive nebulosity with an area void of stars extending towards the south and *south following* directions. The star marked with one dot is apparently involved in the large nebula near the centre of the photograph, and on the *preceding* side of the star is a dark tortuous rift similar in character to that shown on the photograph of H IV. 41 Sagittarii and on others. The rifts prove that the nebulæ are not globular masses, but are like clouds with relatively small depths, and that we can see through them into the darkness of space beyond. There are also very noticeable areas void of stars in the region surrounding the nebulæ here described; and the lines and curves of stars are numerous in this region.

CONSTELLATION STUDIES.

By E. WALTER MAUNDER, F.R.A.S.

I.—THE NORTH CIRCUMPOLAR STARS.

THE workman is nothing without his tools. For the astronomer in general these are his telescopes; his transit circle; his equatorials. But the fathers of the science had none of these, and they supplied the want by making themselves thoroughly acquainted with the groupings of the stars. The naked-eye astronomer of to-day is compelled to follow their example. The stars are his reference points and he must know them thoroughly; he cannot know them too well, and the more complete and exact his acquaintance with them, the better he is equipped for his work. It is by the stars that he marks the beginning and ending of a meteor's flight; by the stars he lays down the windings and channels of the Milky Way, or the soft contours of the Zodiacal Light. I have felt it, therefore, necessary to follow my little notes on the various departments of "Astronomy Without a Telescope" by a series of "Constellation Studies"; an introduction of the student, I would hope, to that fuller, more intimate acquaintance with the stellar groupings which continued and careful star-study will soon give to him.

When, where, or why, the constellations were designed and their names given them, are questions which have received much attention but which remain without a complete solution. The sources from which light can come on these questions may be divided under four chief heads. First, Folk-lore, or oral tradition. This is a rapidly-vanishing factor, and, on that account, it is the more to be desired that those who are brought in contact with the isolated peoples in the corners of the earth should lose no opportunity of trying to find out what these have noticed about the stars, what special groups they recognise, what names they have given them, and what traditions they have preserved about them. Next, what may be called documentary evidence; allusions in classical writers, and the astronomical records of India and China. Thirdly, what we may term—to use a popular and convenient, though somewhat inappropriate expression—the "Assyriological" source; the evidence of monuments and tablets recently discovered in the valley of the Euphrates. This source promises to be the most fruitful and significant, reaching back into a great antiquity, though it has come into our hands but lately. Lastly, there is the evidence of the constellation groups themselves. This internal evidence is necessarily very limited in its character, yet so far as it goes, it is the most important and unmistakable of all; and is especially valuable when it can be applied as a check to assertions or theories based upon external records of either of the three foregoing categories. To follow up any of these researches is also astronomy—"astronomy without a telescope"—although it is not the astronomy of observation. But the material already gathered under these various heads is far too wide to be at all adequately dealt with in the present series of papers. All that can be done will be to give occasional brief notes as to the names of star groups and of individual stars with their most probable meanings.

The most important stars for the student to begin with are those within the circle of "perpetual apparition," the circumpolar stars—those, that is to say, that are within 50° of the north pole of the heavens. A description of these was given in the number of KNOWLEDGE for April, 1900, to which I would make the following additions.

The constellations that immediately surround the North Pole are six in number, five of them ancient; the sixth, Camelopardus, or the Giraffe, was added by Hevelius about 1690.

There is no place for hesitation as to which of these constellations we should begin with.

> "He would scan the figured skies,
> Its brightest gems to tell,
> Must first direct his mind's eye north,
> And learn the Bear's stars well";

the seven stars so well known to our own peasantry as the "Plough" or "Charles' Wain." Wherever men have taken any notice of the stars at all, these seven have been recognised as a natural group, and in earlier ages, being then much nearer to the Pole than now, they were amongst the stars always visible, not only to dwellers in such northern latitudes as our own, but as far south as the tropic of Cancer. It is easy to see how the names of "Plough" or "Wagon" for these seven stars have arisen; their natural configuration has suggested them. The three stars below, as we look at the constellation at midnight at this season of the year, suggest just the kind of curve of a plough handle; and the four above in a rough rectangle, present the ploughshare. Or the four stars above may be considered the four wheels of the rude wagon of which the three below represent the heads of the three horses. "Chariot" or "Wagon" the seven stars have been not only in Northern Europe in our own time but in ancient Greece, and still more ancient Babylonia. Aratus writes of the Pole:—

> "Two Bears
> Called Wains moved round it either in her place."

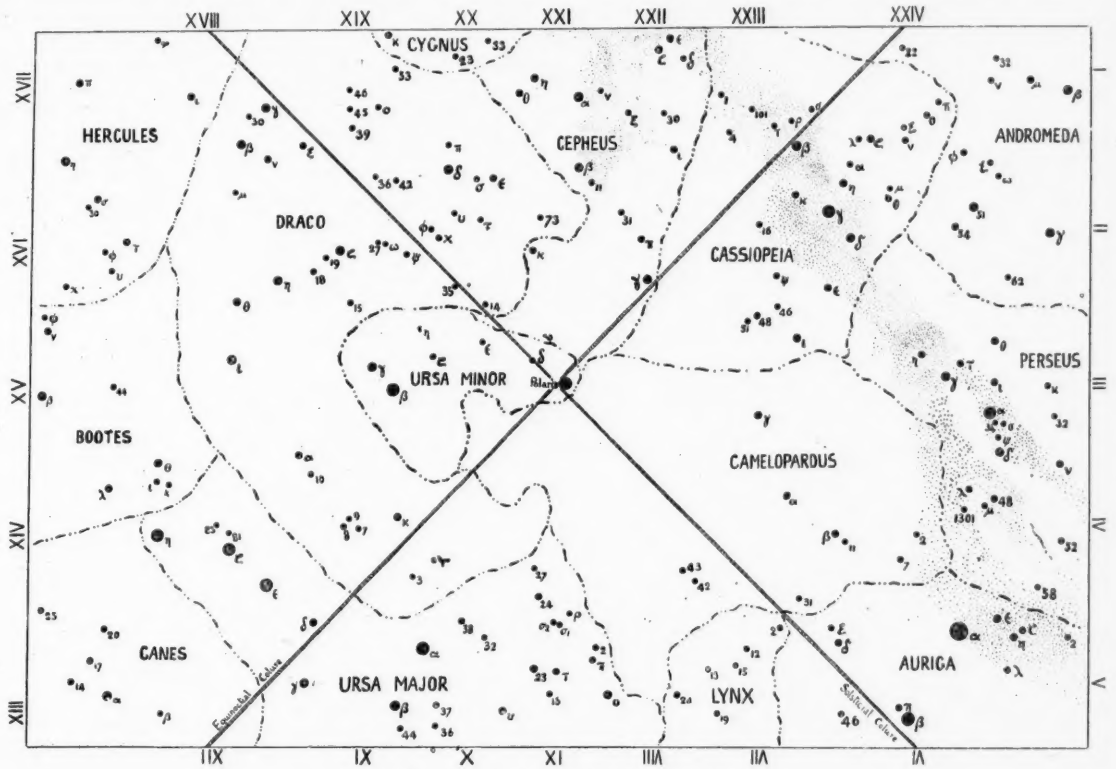
And Homer says that on the shield of Achilles were

> "All those stars with which the brows of ample heaven are crowned,
> Orion all the Pleiades, and those seven Atlas got—
> The close-beamed Hyades, the Bear surnamed the Chariot."

But how the constellation got the name of the Bear is far harder to explain. The Sanskrit name "Riksha"

signifies both "Bear" and "Star," that is, "bright" or "shining" one, and the latter word,—very justly applicable to the seven stars, as being pre-eminently the stars, the shining ones of the northern sky,—may perhaps have been punningly represented by the figure of a bear. But this assumes that the title is Aryan in its origin, which is indeed far from certain. In default of a better theory I am myself inclined to think that the three striking pairs of stars below the Plough suggested the feet of a great plantigrade animal. The lesser Bear no doubt obtained its name from the greater, since its principal stars are a distorted and fainter copy of the seven brilliants of its near neighbour. Classical tradition, according to Aratus, held that they were transferred to heaven as a reward for hiding Zeus in Crete, from his cannibal father Kronos, or else the Great Bear is Callisto, one of Zeus's many loves, and Arcas the Lesser Bear her son. The seven great stars in Job, Chap. XXXVIII., the patriarch is asked, "Canst thou guide Arcturus with his sons?" "Arcturus" being the erroneous rendering adopted in the A.V. for "Aish" the "Bier" or the "Assembly." This star preserves to us, therefore, almost unchanged the name which the constellation bore at the time when the great drama of Job was written.

By far the most interesting object in the whole constellation to the "astronomer without a telescope" is Mizar with its near companion Alcor, 80 in Flamsteed's enumeration. Mizar is in every way the first of the double stars. Alcor forms with it a double to the eye; it has a much closer bright companion which rendered it the first double star to be detected in the telescope, it was the first double star to be photographed, and it was the first case in which the spectroscope showed that the principal star which appears to us even with the most powerful telescope as single is really in



Star Map No. 1; North Circumpolar Region.

of the Plough are now known by the seven first letters of the Greek alphabet, proceeding in order from the front of the ploughshare back to the handle. The names which they popularly bear at the present day are as follows:—Alpha is Dubhe, that is, the "bear"; Beta, Merak the "loin"; Gamma is Pheeda the "thigh"; Delta, the faintest of the seven, is Megrez, "the root of the tail"; Epsilon is usually called Alioth; but whether this name has much authority is not clear; Zeta is Mizar, a "girdle" or "waistcloth"—but this is a comparatively modern appellation; Eta, the star at the tip of the tail, has the most interesting name of all, since it is called Alkaid or Benetnasch; the two names together meaning the "chief of the daughters of the Bier." It will be remembered that itself double. Epsilon Ursae Majoris marks very nearly the place of the radiant point of a shower of Ursid meteors, the date of which is the 30th of November. For those astronomers who add the opera-glass to naked-eye work, the three stars of the plough handle and their immediate neighbourhood offer many interesting fields. So, too, the feet of the Bear, the three pairs of stars to which we have already alluded, are also worth studying with this amount of optical aid. The fore foot is composed of Iota and Kappa, Lambda and Mu mark the next, Nu and Xi the last.

Beta and Alpha are, as is well known, commonly called the "Pointers," inasmuch as the straight line drawn through them leads us very nearly to the Pole Star, which is about the same distance from Alpha as Alpha

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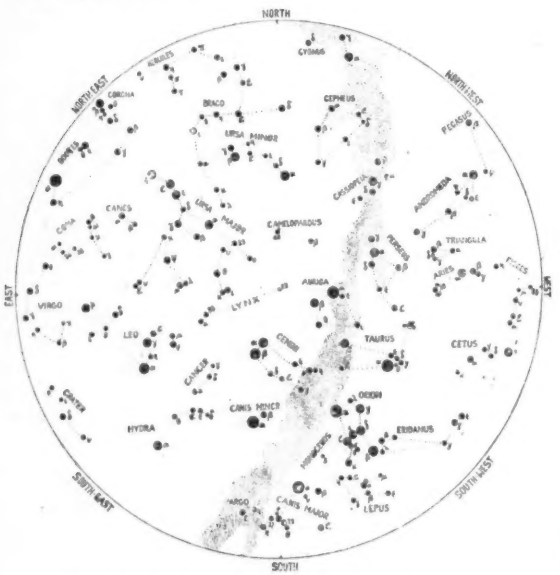
is from Eta. The name given it, from its nearness to the Pole, Polaris, is so universally applied to it, nowadays, that there is little need to notice the many Arabic names which it has borne. An opera-glass, however, shows us other fainter stars yet nearer the Pole, of which the chief is Lambda Ursae Minoris, just on the limit of unassisted vision, whilst Groombridge 1119 is fainter still. Three other stars, visible to the naked eye, may be mentioned as within $3\frac{1}{2}^{\circ}$ of the Pole; Cephei 51, a designation which it owes to Hevelius, as it lies within the boundaries of Ursa Minor as the constellation is usually drawn nowadays; Delta Ursae Minoris; and Bradley 3147. This little group of stars, though not attractive to the sight, is of the utmost importance astronomically, since its components enable the professional astronomer to test the accuracy with which his transit instrument points to the north at intervals of about two hours.



The Midnight Sky for London, 1901, January 5.

Beta and Gamma are the only two other conspicuous stars of the constellation. Beta was once the Pole Star, or at any rate divided the title rôle with Kappa Draconis, and hence bears the name Kochab, "The Star," that is to say, the Northern or Pole Star. Gamma is a wide double star to the eye, Al Farkadain, the "calves," usually written Pherkad on our globes.

The constellation is the seat of several of the minor radiants. In September, there is one from the neighbourhood of 51 Cephei; in April, there is another from near Gamma Ursae Minoris.

Between the two Bears, and almost encircling the Lesser, is a long winding stream of stars, making up the constellation of the Dragon. It is certainly one of the most ancient of all, and is believed by many to be the crooked serpent of Job, xxvi. 13. Alpha of this constellation, now generally called Thuban, i.e., "Dragon," and situated midway between Gamma of the Lesser Bear and Zeta the Greater, was the original Pole Star of the heavens when the constellations were mapped out, a pre-eminence it must have held for over 2000 years. Within this constellation also is the pole of the ecliptic, almost in the centre of the great loop made by the Dragon's folds.

At midnight on New Year's Day, the Dragon's head reaches down almost to the northern horizon, two bright stars, Gamma and Beta, marking the top of its head. Of these the more westerly is of a rich orange tint, and is the zenith star of Greenwich, and as such was specially observed by Flamsteed, Bradley, and Airy, the second of whom made his discovery of the aberration of light in connection with it. Three stars, Xi, Nu, and Mu, make up the jaw, Mu being at the snout. Nu, the faintest of the three, is an opera-glass double.

Why this constellation got its fearsome symbol is not clear. It is true that the Dragon or snake was amongst all ancient nations used to symbolise the powers of evil, of darkness, or of chaos. But that gives us no explanation why a constellation, far from being the least beautiful and conspicuous, has been chosen to convey this idea of darkness; still less why such a symbol should have been planted at the very crown of the celestial sphere.

From Epsilon in the Great Bear a line through Polaris leads us to a small constellation, yet one of the most easily recognisable in the sky, Cassiopeia, the "Lady on her Throne," her principal stars, five in number, suggesting a W freely scrawled. The constellation at this time is west of the Pole, the highest star is Epsilon, then following the other points of the W in order, we have Delta, Gamma, Alpha, Beta. The only stars of the five which in modern days are often referred to by their Arabic names are Alpha, Schedar or "Breast"; and Beta, Caph or "Hand," or possibly in some allusion to her husband Cepheus who stands by her side. The latter forms a larger but much less conspicuous constellation, lying between Cassiopeia and the Dragon, its four chief middle stars forming a lozenge; the point of the lozenge most remote from Cassiopeia is Alpha, Alderamin, the "right arm," the only one commonly referred to now by its Arabic name. Delta is one of the most interesting of the naked-eye short period variables.

Cepheus and Cassiopeia are especially interesting since they with three more southern constellations make up a recognised and unmistakable story pictured in the sky; a clear proof that the work of original constellation making was deliberate and not haphazard, and that the legends there represented were in existence before the star groups were made. Brown argues justly that Cepheus is manifestly a non-Hellenic sovereign. He is indeed often spoken of as Ethiopian, but the Ethiopia there meant is not Nubia or Abyssinia, but the Euphratean "Cush." Hence there is no justification for those too precise artists and poets who have represented poor persecuted Andromeda as a sable beauty, "black" if "comely."

Cassiopeia is a constellation that well repays opera-glass scrutiny, and it also furnishes to the naked-eye astronomer several important meteor radiants, of which one from near Delta deserves especial notice, and it is an especial favourable neighbourhood in which to commence the study of the Milky Way, since the constellation passes through our English zenith. It is most famous historically from the appearance of the celebrated Nova of 1572—the "Pilgrim Star"—which formed very nearly the fourth point of the square, or rather rhombus, of which Alpha, Beta, and Gamma mark the other three points.

Camelopardus is a great straggling constellation, all the stars of which are faint, which lies between Ursa Major and Cassiopeia, and stretches upwards almost to the Pole.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS HUMAN LIFE POSSIBLE ON OTHER PLANETS?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I have just come across a passage in Grant Allen's little book, "The British Barbarians," in which he states that "planetoscopists" are agreed that there is no form of living creature in any of the planets that can be called "human," because the physical conditions are in all probability so different from those on this planet that the life which probably does exist there, as here, will have followed a very different course of development or evolution.

I should be very glad if you could inform me in KNOWLEDGE whether this statement of the views of those who have made a special study of the planets is correct. I had a notion that it was considered that the physical conditions of Mars (*e.g.*, so far as they can be known or guessed at) are so like those of this earth as to make it probable that human beings may be living there.

Of course I know that a scientific man would be very reluctant to commit himself to an opinion on a question for the solution of which there is so little evidence available as there is for this question of possible human life elsewhere than on this earth; and for that very reason I thought Grant Allen's statement was too definite and sweeping.

Churchstanton Rectory, ARNOLD D. TAYLOR.
Honiton, October 31st, 1900.

PHOTOGRAPHIC SEARCH FOR THE LEONIDS.

Mr. J. Maclair Boraston watched for the Leonids on November 14th, from 12h. to 14h.; 5 meteors were seen—3 of them being Taurids, and 2 probably Leo Minorids. "The result was that no true Leonids appeared." Mr. Boraston also exposed a plate from 13h. 15m. until 14h. The star trails are not, however, true curves, but show slight irregularities, for which Mr. Boraston enquires the cause.

We have examined the photograph sent, and the irregularities are manifestly due to small motions of the camera.—E. W. M.

CONSTITUENTS OF THE SUN.

"Nemo" enquires whether the experiments of Prof. Janssen, conducted at the summit of Mont Blanc, has not proved that oxygen is wanting in the sun.

No; Prof. Janssen showed that the great absorption bands given by the oxygen in our atmosphere are not also given by absorption in the solar atmosphere. But the temperatures of the atmospheres of the two bodies are so entirely different that this is no criterion. It simply shows that oxygen does not exist in the sun at terrestrial temperatures.

"Nemo" also finds the prominences an extremely striking feature in the dark lines of calcium, as seen on a photograph of the solar spectrum, and asks "Is it not then safe to suppose that they are either wholly or partially due to incandescent calcium vapour instead of hydrogen, as it is usually stated?"

Certainly they are partially due to calcium, even largely so. But their striking relief on the H and K lines is due to the great breadth and darkness of the corresponding Fraunhofer lines of the solar spectrum. They are brilliantly seen on the hydrogen lines, notwithstanding that the dark lines of hydrogen by no means furnish so good a background for them.—E. W. M.

Notices of Books.

"ATMOSPHERIC RADIATION." A Research conducted at the Allegheny Observatory and at Providence, R.I., by Prof. Frank W. Very.—This research took its origin in a problem suggested by Prof. Cleveland Abbe to Prof. Very in 1891, as to whether absorption is the absolute inverse of radiation for gases. It deals with a subject intimately connected with that which Mr. W. E. Wilson takes up in his Daramona Observations, lately published, but whereas Mr. Wilson has to do with the radiation from gases at the enormous temperature of the sun's surface, Prof. Very tries to determine the absolute radiation in calories from a unit mass of gas at given temperature and density and at ordinary temperatures, not when burning, not when electrified, but when simply heated. The difficulties of the problem are very great, for, as Prof. Very says, "The investigator here is dealing with the invisible and the evanescent. In an optical apparatus a little stray light immediately attracts attention, and we proceed to trace it to its source with our eyes open. In our study of feeble invisible radiations, on the other hand, we grope in the dark, and only succeed in eliminating the unwelcome extraneous rays after innumerable trials and errors." It is quite impossible here to give any account of the methods of research or of all the results obtained; we must confine ourselves to but a few points which appear to bear directly on solar physics. As an absorbent of terrestrial radiation, aqueous vapour is very much more efficient than any other atmospheric ingredient; but as radiators when in large masses, the substances composing the atmosphere do not differ so widely as might be supposed, since the facility with which a highly radiative vapour parts with its heat is largely annulled by self-absorption in its deep layers of its own radiations, and since in gases heat is transferred from molecule to molecule with the greatest ease, it is the feebly radiative molecules which act as radiators, except in the comparatively thin outer layers. The depth of gas which gives maximum radiation at short range is an insignificant quality compared with atmospheric dimensions, and radiation from either the atmosphere of the earth or the solar chromosphere is a superficial phenomenon, even when the masses of heated gas measure thousands of miles in thickness. The fineness of the chromospheric lines in the solar spectrum, although the shifts of the Fraunhofer lines indicate pressures of many atmospheres at the base of the chromosphere, is a sufficient demonstration that only the outer layers radiate. Prof. Very also confirms and extends Mr. Evershed's results on the heating of iodine and its kindred vapours, that the light emitted by these glowing vapours appears to give a perfectly continuous spectrum while the corresponding absorption-spectra are selective. "Thus there is no such close relation between emission and absorption as is implied by Kirchoff's law of radiating bodies. There seems, however, to be a general relation between the total absorbing and radiating power for the visible rays." These points seem to have a very close bearing on the question of the relation between the Fraunhofer and "Flash" spectra.

"THE RIDDLE OF THE UNIVERSE." By Ernst Haeckel. English edition. (Rationalist Press Association.) 6s. net.—However unwilling we may be to accept some of the conclusions arrived at in this book, it is impossible not to admire the man who has written it. Towards the close of a life devoted to science he has, in "The Riddle of the Universe," summed up in popular form his views on all the great questions that affect mankind. His wealth of accumulated knowledge enables him to sweep from one great problem to another with astonishing ease and power. He first briefly summarises the evidence of evolution. Comparative anatomy and physiology alike forbid us to separate man from the apes. Embryology puts it beyond a doubt that men have been by gradual stages evolved from a simple type of organism. After an enthusiastic appreciation of the work of Darwin, he discusses the "Nature of the Soul," writing as a convinced monist, to whom dualism in any form is an abomination. The soul cannot exist apart from the body, nor the body apart from the soul. "Athanatism," the immortality of the soul, is inconsistent with the very principle of monism. The individual perishes, but according to the "law of substance" matter is eternal. The chemical law of substance must be associated with the physical law, the conservation of

energy. The sum of matter and the sum of force in the universe are unchangeable. The law of energy holds true in physiology. The growth, sensation, and movement of living organisms depend on the conversion of the potential energy stored in their food into kinetic energy. We now proceed to the monistic cosmogony. "The world (*i.e.*, apparently, the universe) has no beginning and no end." The world and all living organisms upon it have been evolved. There is an absolute unity of nature. We cannot deny the affinity of the organic to the inorganic; the elements contained in both are the same. This monistic philosophy leads inevitably to Pantheism.

Even in Prof. Haeckel's statement of the theory of evolution there is much to criticise. He has not got rid of Lamarckism. Without even discussing the subject he decides that instincts are due to inherited habit, appealing to Darwin, though Darwin maintained that most instincts had quite a different origin. Moreover, we want to know on what lines evolution is proceeding among civilized races; whether, for instance, science and wealth are bringing about physical degeneration. On this he is silent. Intellectual freedom, he maintains, would bring about *progress in science and civilization*, but as to further *evolution* he is silent. He exaggerates the achievements of science. We know nothing about the origin of matter; yet he stoutly maintains that the universe has had no beginning. In the concluding pages, however, he speaks more reasonably: "We grant at once that the innermost character of nature is as little understood as it was by Anaximander." One more criticism. He attacks religion with an acrimony that is out of place in a scientific work. His hatred of it blinds him to the fact that the evolution of civilized man (of Professor Haeckel himself, with his strong love of truth and justice) would not have been possible without the alliance of religion with morality. A life of controversy has left its mark on Professor Haeckel. There are subjects on which he cannot touch without losing his patience, and sometimes even his dignity.

"THE ROYAL OBSERVATORY, GREENWICH: A GLANCE AT ITS HISTORY AND WORK." By E. Walter Maunder, F.R.A.S. (Religious Tract Society.) Illustrated. 5s.—To the public at large the Royal Observatory is forbidden ground, and we are therefore especially grateful for this authoritative account of our national observatory and its work. The story of the foundation and development of the Observatory forms an important chapter in the history of science, and it is here admirably told from first-hand sources in a popular manner, but with sufficient fulness to form a valuable work of reference. Commencing with the pathetic figure of Flamsteed—without assistance or instruments other than he chose to provide out of his meagre salary of £100 a year—the gradual acquisition of buildings, instruments, and staff under the rule of succeeding Astronomers-Royal is traced step by step; and, finally, the reader is conducted through the various departments as they exist to-day. Doubtless many who believe that to be a professional astronomer is to sit at the eye-end of a telescope and admire the glories of the heavens will be disillusioned on reading this book. The busy hive of workers, mostly employed in laborious calculations at their desks, forms quite another picture, but the author, who is so well known to our readers, has the skill to reveal the inner beauties of even this very serious side of astronomical work. It is made quite clear also that it is not to such an institution as that at Greenwich that we must look for "discoveries" in astronomical science, the aim being more especially to cultivate those branches of work which demand continuous observations extending over many years, and which cannot therefore be left to the efforts of amateurs. It is well to recall the fact that the Royal Observatory was founded primarily, and has since been maintained, for the strictly practical purpose of assisting navigation, by obtaining a better knowledge of the motions of the moon and of the positions of the stars for application to the determination of longitude at sea. Expansion in various directions, however, was inevitable, but assistance to navigation has always been the first object of the work of the Observatory. The book is brightly written throughout, and gives much valuable information in an unobtrusive way, not only with reference to this particular observatory, but on a great variety of astronomical subjects. It is beautifully illustrated, with portraits of the eight Astronomers-Royal, and many photographs of instruments and observatories. To those interested in astronomy the book is an excellent substitute for a personal visit to the Observatory, and even those who may obtain the great privilege of a visit will find that they will see a great deal more by having first learned what to look for.

"PHOTOGRAMS OF THE YEAR 1900." Compiled by the Editors and Staff of the *Photogram* assisted by A. C. R. Carter. 3s. (Dawbarn and Ward.)—This comprehensive annual should be in the hands of every photographer, both for his pleasure and his profit. In its well-arranged pages are produced not merely a good display of all sorts of prints, but also articles by writers who are entitled to speak with authority. These articles are selected with the object of exemplifying opposite views of photography. Hence we have one writer, Herr Ernst Juhl, full of praise for "gum" printing, and expatiating on its possibilities in the hands of certain German workers. And, in direct antagonism, an article by Dr. P. H. Emerson, in which he vigorously condemns, not only "gum" printing but also "faking," and he apparently would allow no handwork at all. To this lack of agreement among experts we may obviously assign the variety of grotesque photographs which are accorded prominence in the annual exhibitions. Photographs which arrest the eye solely because they startle, are so frequently held up to admiration for their originality that the multitude of unhappy productions of this kind have already made "artistic photography" the laughing stock of artists. No better instance is wanted than that of a production labelled "In the Marshes," on page 15 of *Photograms of the Year*. But perhaps the fact that but few such prints are given in this book is a sign of increasing sanity in photography.

"STUDIES IN FOSSIL PLANTS." By Dukinfield Henry Scott, M.A., PH.D., F.R.S. Illustrated. (Black.) 7s. 6d.—Botanical readers have long since learned that anything which proceeds from Dr. Scott's pen demands their best attention. The volume before us, the latest addition to the rapidly increasing literature of "Fossil Botany," is, in every respect, up to the high standard which the author has attained in his previous works. Fossil plants, until recently, have received but slight attention from the botanist, and for the geologist they have had but little interest, except as characteristic marks by which certain strata can be recognised. Among living English botanists who have studied these records of the plant life of past ages, perhaps none have done more important work than the author of this volume, and he is, therefore, peculiarly qualified to present us with an account of the present condition of our knowledge of the subject. Taking for his text the classic phrase in which Count Solms-Laubach stated the object of the study of fossil plants, "the completion of the natural system," Dr. Scott records "those results of palæobotanical enquiry which appear to be of fundamental importance from the point of view of the botanist." These are found almost entirely in the two sub-kingdoms 'Pteridophyta" and "Gymnospermæ," which alone are dealt with. The fossils considered are such as are "well-characterised"; more doubtful specimens being wisely disregarded. The treatment of the subject is exceedingly clear, and the work cannot fail to be of absorbing interest to the student of living plants who desires a stereoscopic view of the vegetable life of the globe. The capital illustrations which abound, show the remarkable fidelity with which even minute details of the structure of vascular plants have been preserved by petrifaction, and add considerably to the value of the work to the palæobotanical reader.

"REPORT OF THE KITE OBSERVATIONS OF 1898 BY THE DEPARTMENT OF AGRICULTURE, U.S.A."—The observations were made with Box Kites, at seventeen stations in North America. The mean rate of diminution of temperature with increase of altitude, as determined from 1217 ascensions and 3838 observations, taken at elevations of 1000 feet or more, was 5.0° for each 1000 feet. The largest gradient, 7.4° per 1000 feet, was found up to 1000 feet, and thereafter there was a steady decrease up to 5000 feet, the rate of decrease becoming less as the altitude increased. The relative humidities at and above the earth's surface differed little except at 7000 feet, where the surface humidity was 11 per cent. less than that above. There was a steady but by no means uniform decrease of vapour pressure with increase of altitude.

"ANNUAL REPORT OF THE PARIS OBSERVATORY."—Of late years the Paris Observatory has given in each annual report a very beautiful and practical specimen of the work accomplished, in a heliogravure of the moon, photographed by MM. Lewy and Puiseux, with the Grand Equatorial Coudé. The plate this year was taken on 1899, February, 6d. 16.5h., when the moon was aged 6d. 8.8h., and the Mare Serenitatis was half in shadow, its western wall showing very dimly against the sky. The chief point of interest, indeed, in the report, relates to the great lunar photographs, and especially to the giant presentations of 1.38m. of the moon in the first and last quarter, exhibited at the Paris Exhibition. Besides the work of the great lunar atlas, and the other routine observations, connected with the meridian and astrographic departments, M. Hamy has conducted a series of interference measures with the object of determining the wave-lengths of a certain number of standard points in the spectrum.

"THE PATH OF THE SUN: ITS ORBIT AND PERIOD OF REVOLUTION DEMONSTRATED." With an Exposure of the Fallacy of the Precession of the Equinoxes. By William Sandeman, F.C.A. (Simpkin.)—The phenomena produced by the rotation of the earth on its axis in 24 hours, could also be explained by a rotation of the entire heavens on a similar axis in a similar time. So the phenomena produced by the revolution of the earth round the sun in a year could also be produced by the revolution of the sun round the earth. We have plenty of paradoxers to uphold both doctrines. The gross improbability of their assumptions does not strike them, and they are either ignorant of those facts which are irreconcilable with their theories, or they have not sufficient discernment to see how they bear upon them. Mr. Sandeman falls into an error, precisely analogous in its character, but dealing with a somewhat more recondite question. He refers the rotation of the axis of the earth in the precessional cycle of nearly 26,000 years to a revolution of the sun and the entire solar system in a similar period. The paradox is therefore practically the same in nature as those with which the "flat-earth" and the "immovable-earth" people have made us so familiar.

"ANNALS OF THE LOWELL OBSERVATORY," Volume II.—The second volume of the "Annals of the Lowell Observatory" is like the first, sumptuously prepared and fully illustrated. It deals with the two planets Jupiter and Mars; the first was observed in 1894 and 1895, the latter in 1896 and 1897. The observations of Jupiter itself dealt with the polar flattening, which was found to be 1/16.11, and with refraction in its atmosphere. The amount of refraction found was considerable, namely a refraction of 8′ of arc in the outer atmosphere. The depth of the atmosphere would appear to be great—2800 miles is suggested—with a slow decrease in the refractive power and density. But much more attention was given to the satellites, of which a great number of beautiful little drawings are given. Of the satellites, the first was considered to be markedly elliptical, being a prolate spheroid, revolving end over end about one of its minor diameters in a period of 13 hours. Of satellite II., little could be made out. The third satellite showed a slight ellipticity, but several surface details were detected, which may be described as a northern belt, crossed occasionally by another line or belt, rarely a central forked belt, and once a southern belt. The fourth satellite also showed a slight ellipticity. Both third and fourth satellites kept the same face always turned towards their primary, whilst the rotation of the first satellite was much more rapid than its revolution. The greater part of the volume is, however, given to the planet Mars, and the researches detailed in the first volume of the "Annals" are continued in this. The meteorology of Mars, it is inferred, resembles that of our own earth, except in so far as they are affected by the limited water supply. There appears to be a great transference of moisture from one hemisphere to the other, twice in the course of the Martian year, chiefly by an ærial transmission. "Radiation and polar clouds are the more common forms on Mars, cyclonic and conventional clouds are very rare." The observers are inclined to ascribe many of the dark markings to vegetation. "The surface of the planet seems likely to be level, but large raised areas exist in the polar regions. . . . The mean temperature at the poles is likely to be not far below freezing, the contrast between day and night is considerable." Whatever reluctance may be felt to accept the conclusions of the Lowell observers in their fulness, there can be no question that the principle they adopted of making these planetary observations as continuously as possible, and not spasmodically, is the right and true one. It is the only method, and it is a certain one, for making substantial progress in our knowledge of the conditions of the planets.

"WILLIAMS AND NORGATE'S BOOK CIRCULAR."—We have received a most useful volume from Messrs. Williams & Norgate, comprising eight monthly issues of their *Book Circular*. This publication contains well-written and critical notes on new and forthcoming books, chiefly Continental. It should be of considerable value to scientific workers.

CATALOGUES.—We have received useful catalogues of electrical apparatus, from Messrs. W. & J. George, Limited; of microscopes and microscopic slides, from Mr. C. Baker; of cabinets, birds' eggs and skins, butterflies and moths, from Messrs. Watkins and Doncaster; of bioscopes and of cinematograph films, from the Warwick Trading Company, Limited; a pamphlet on the Kammatograph, from Messrs. Kamm & Co.; a Radiographic list from Messrs. Isenthal & Co.; and supplementary list of lantern slides from Messrs. Newton & Co.

BOOKS RECEIVED.

The Progress of Invention in the Nineteenth Century. By Edward W. Byrn. (New York: Munn & Co.) Illustrated. $3.

Report on the Census of Cuba, 1899. (Washington: Government Printing Office.)

Railway Runs in Three Continents. By J. T. Burton Alexander. (Elliot Stock.) 7s. 6d. net.

Botany: An Elementary Text for Schools. By L. H. Bailey. (Macmillan.) Illustrated. 6s.

Botany. By R. S. Wishart, M.A. (The Self-Educator Series.) (Hodder and Stoughton.) Illustrated. 2s. 6d.

The Self-Educator in French. Edited by John Adams, M.A., B.SC. (Hodder & Stoughton.) 2s. 6d.

One Thousand Objects for the Microscope. By M. C. Cooke, M.A., LL.D, A.L.S. New Edition. (Warne.) Illustrated. 2s. 6d.

All Change. By Wilfred Woollam, M.A. (Elliot Stock.)

What is Heat? and What is Electricity? By Frederick Hovenden, F.L.S., F.G.S., F.R.M.S. (Chapman & Hall.) Illustrated. 6s.

A New Practical Method of Learning French Colloquially. By L. B. Meunier. (Philip & Son.) 2s.

The Structure and Life History of the Harlequin Fly. By L. C. Miall, F.R.S., and A. R. Hammond, F.L.S. (Clarendon Press.) Illustrated. 7s. 6d.

Hand-Book of Practical Botany. By Dr. E. Strasburger. Translated by W. Hillhouse, M.A., F.L.S. 5th Edition. (Swan Sonnenschein.) Illustrated. 10s. 6d.

The Romance of the Earth. By A. W. Bickerton. (Swan Sonnenschein.) Illustrated. 2s. 6d.

A School Chemistry. By John Waddell, B.A., B.SC. (Macmillan.) Illustrated. 4s. net.

By Land and Sky. By the Rev. John M. Bacon, M.A., F.R.A.S. (Isbister.) Illustrated. 7s. 6d.

Annuaire Astronomique, 1901. Par Camille Flammarion. (Paris: Flammarion.) Illustrated. 1fr. 25.

Table of Divisors. By Thomas Dence. (Mayfair Works.)

The Complete Works of John Keats. Edited by H. Buxton Forman. Vol. I. (Glasgow: Gowans & Gray.) 1s. net.

Table Générale des Publications de la Société d'Anthropologie de Paris. (Paris: La Société d'Anthropologie) 6fr.

The Story of Thought and Feeling. By Frederick Ryland, M.A. (Newnes.) 1s.

Jewellery and Trinkets. By Alice Teague. (Dawbarn & Ward.) Illustrated. 6d. net.

The Heavens at a Glance, 1901. Card Calendar. By Arthur Mee, F.R.A.S. 7d. Post free.

The Story of Nineteenth Century Science. By Henry Smith Williams, M.D. (Harper and Brothers.) Illustrated. 9s.

The Principles of Magnetism and Electricity. By P. L. Gray, B.SC. (Methuen & Co.) 3s. 6d.

Lord Lilford: A Memoir by his Sister. (Smith, Elder & Co.) Illustrated. 10s. 6d.

Practical Lessons in Metal Turning. By Percival Marshall. (Dawbarn & Ward.) Illustrated. 2s. net.

Who's Who, 1901. (A. & C. Black.) 5s. net.

Englishwoman's Year Book. (A. & C. Black.) 2s. 6d. net.

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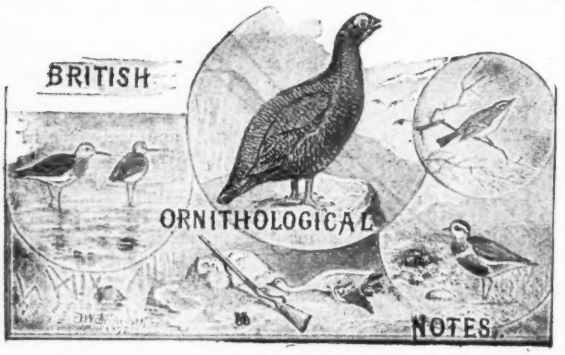

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

BIRD MIGRATION IN GREAT BRITAIN AND IRELAND.—At the meeting of the British Association in 1896, it will be remembered that the Bird Migration Committee published a most important Digest of the Observations on the Migrations of Birds at Lighthouses and Light-vessels from 1880 to 1887.* This Digest was the work of Mr. W. Eagle Clarke. Important and satisfactory as it was, it was only considered as the foundation for future work. Undaunted by the magnitude of his task, which cannot be exaggerated, Mr. Clarke has not only continued his work of systematically tabulating the 100,000 records of the lighthouses, but he has added to this mass of facts many more thousands of observations culled from the voluminous literature published during the period covered by the enquiry. Four years of incessant toil since the publication of the Digest enabled Mr. Clarke to gather, sift, and arrange, in conjunction with the lighthouse reports, this additional matter, so that the data being now as complete as possible, "the time has arrived when, for the first time in the annals of British Ornithology, it is possible to write an authoritative history of the migration of each British bird." And not only is this possible, but we believe that Mr. Clarke has so far advanced this most important and valuable work that its publication will not now be long delayed. As examples of his method of treating the subject, Mr. Clarke furnished the British Association last year with a summary of details of the various migratory movements of two species—the Song Thrush and the White Wagtail. The following brief abstract of one of these may interest those who have not had an opportunity of reading the original paper:—

THE MIGRATIONS OF THE SONG THRUSH.—The Song Thrush furnishes a most excellent example of the complex nature of the phenomena of bird migration as observed in Great Britain and Ireland. Its various movements cover a period of nearly ten months of the year. Throughout August and more especially in September and October many Thrushes, which have bred here, move southward to winter in warmer climes. At the end of September and during the whole of October great numbers of Thrushes from North-Western Europe invade the north-east coast of Great Britain. Of these foreign-bred birds many proceed south and finally quit our shores, the majority to seek more southern lands, but others to winter in Ireland. Others, again, remain as winter visitors in England. This immigration of Thrushes from the Continent, unlike that of other species, ceases with the month of October. In the winter (from October to February) we have a different kind of migration. These movements are entirely due to outbursts of cold or bad weather. At such times immense numbers of Thrushes, both residents and intending winter visitors, rush to the coasts, along which they proceed south and west. If the cold continues many leave the country altogether, while others find refuge in Ireland. During February and March our own Thrushes, which left us in the autumn to winter in the south, gradually begin to return. Towards the end of March the Thrushes which have wintered in the islands off the west of Scotland and Ireland take their departure for Northern Europe. Throughout April those that have wintered in the mainland depart as they came, *via* the north-east coast of England and the east of Scotland. Merged somewhat with this latter movement are the travellers which pass during April and occasionally in May along our eastern seaboard on their way from the south to the north of Europe.

These are the main points in the complicated migratory movements of the Song Thrush in Great Britain. All ornithologists will heartily agree with the Migration Committee that "A great debt of gratitude is due to Mr. Clarke for the courage and perseverance which he has shown in grappling with the enormous mass of statistics necessary to afford the results so lucidly and concisely summed up by him."

BAIRD'S SANDPIPER IN SUSSEX.—A NEW BIRD TO THE BRITISH LIST.—At the meeting of the British Ornithologists' Club, held on November 21st, 1900, Mr. Ernst Hartert exhibited a young female specimen of Baird's Sandpiper (*Heteropygia bairdi*). The bird was shot at Rye Harbour, Sussex, on October 11th, by Mr. M. J. Nicoll. Mr. Nicoll wrote that the flight was like that of the Common Sandpiper for the first few yards, then the bird rose straight in the air for a considerable height, and then dropped suddenly towards the ground. It did this every time it was flushed. Its cry was a shrill twitter, different from that of any British species. The bill and legs were jet black. Baird's Sandpiper is an American species.

BRITISH FORM OF THE WILLOW TIT (*Parus salicarius*).—In KNOWLEDGE for April, 1898, p. 81, we drew attention to this bird, which Mr. Hartert introduced to the British list from specimens obtained at Finchley. At the November meeting of the British Ornithologists' Club, Mr. Hartert announced that he had found a specimen in the collection of Mr. Ticehurst, from St. Leonards, and had recently received fresh skins from Mr. Ruskin Butterfield, from Hastings. The bird would no doubt be detected in other localities, when British ornithologists were able to distinguish the Willow Tit, with its dull head, from the ordinary Marsh Tit with its glossy crown. Ornithologists will do well to carefully observe Marsh Tits, in the hope of distinguishing the Willow Tit, and thus obtain more evidence regarding the bird in Great Britain. There is a little difficulty about the name of the bird. For those who accept trinominals and unite all the dull-headed forms of the Grey Tits, the Continental Willow Tit would be *Parus montanus salicarius*, and the British form *Parus montanus Kleinschmidti*; otherwise the British Willow Tit might be called *Parus Kleinschmidti*, since it differs from the Continental form by being slightly smaller and more richly coloured. Those who do not recognize the slight differences of the Continental and British forms of the Tits as worthy of specific rank should call the bird *Parus salicarius*, and in taking Mr. Saunders' Manual as the standard book on British birds, and following his decisions regarding the Long-tailed Tit and the Coal Tit, we are inclined to call the Willow Tit simply *Parus salicarius*.

* For Summary of this Digest *see* KNOWLEDGE, November, 1896, pp. 254—256.

The Birds of Yorkshire.—The Honorary Secretary of the Yorkshire Naturalists' Union announces that Mr. T. H. Nelson has undertaken to continue and complete Mr. W. Eagle Clarke's work on the "Birds of Yorkshire," which has been partly published in the *Transactions* of the Yorkshire Naturalists' Union, and the continuation of which was interrupted by Mr. Clarke leaving Yorkshire to settle in Edinburgh. Considering the length of time that has elapsed, and the number of records and observations of Yorkshire birds which have accumulated since Mr. Clarke wrote his last instalment of this work, we think it unwise to continue the publication. Good as we know Mr. Clarke's work to be, such revision is required in bringing it up to date that nothing short of re-writing would be satisfactory. Moreover, Messrs. Oxley Graham and James Backhouse have long been engaged on a work on the birds of Yorkshire, the manuscript of which we understand is now nearly complete.

Pectoral Sandpiper at Aldeburgh (*Zoologist*, November, 1900, p. 521). Mr. E. C. Arnold records that he shot a specimen of *Tringa maculata* on September 13th last at Aldeburgh, Suffolk. This bird has occurred in England more frequently than any other American wader, and has already been recorded four times from Suffolk.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

THE INSECTS OF THE SEA.

By GEO. H. CARPENTER, B.SC.(LOND.), *Assistant in the Museum of Science and Art, Dublin.*

INTRODUCTORY.

MARINE insects have been somewhat neglected both by entomologists and by students of the "common objects of the sea-shore." An ardent insect-hunter will quickly fill his boxes, as he wanders over the hillside, or sweeps along the thick undergrowth of the woodland, while hours of work along the tidal margin may yield him but a few obscure flies and beetles. And the naturalist who finds especial delight in the rock-pool or the wave-swept beach, is usually so engrossed with his shells or his zoophytes that he does not notice the insects lurking beneath the stones or crawling among the seaweed. Hence so keen a naturalist as the late P. H. Gosse* told his readers forty-five years ago that "of the hundreds of thousands of insects known to exist but *two* live in the sea." Even at that date the statement was much under the mark. Leach, Guérin, and Haliday had years before detected and described many of the shore-haunting insects which will be mentioned at length hereafter; while as early as 1822, Eschsholtz had made known the wonderful bugs of the genus Halobates, the only insects whose whole life is spent on the open sea. In 1871, A. S. Packard† mentioned some dozen marine species from the Atlantic and Pacific coasts of North America. References to marine insects in the works of recent writers—Moniez‡ and Miall§ for example—show that some scores of kinds probably occur on our own coasts, most of the important orders being represented. And it is likely that the marine insects of the whole world will be found to number some hundreds of species.

Still the insects of the sea seem but an insignificant group when we compare them with the well-nigh countless kinds of insects that inhabit the air and the land, two millions according to the lowest recent estimate, and ten millions if we may accept the opinion of so careful a naturalist as the late C. V. Riley. Hundreds only as compared with millions! it might easily be thought that marine insects are unworthy of the naturalist's attention. Yet their poverty in numbers is really a sign of the value of the study; creatures so few in comparison with their class as a whole must have something exceptional about them, and their form and life-history must yield results of high interest to the patient enquirer.

Insects are pre-eminently creatures of the air and the land. The power of flight possessed by most insects, the wonderful system of branching tubes found in almost all—carrying air to all parts of the body so that oxygenation of the blood goes on everywhere—mark them out as essentially a class of air-breathing animals. It is well known that many insects pass the earlier stages of their life-history in streams and ponds, but comparatively few of the grubs have acquired the power of breathing the air dissolved in water. Most aquatic larvæ, and all the insects which live in water when adult, have to come into touch with the upper air when they want to breathe. Prof. Miall's fascinating work on aquatic insects, to which reference has already been made, is largely occupied with descriptions of the wonderful adaptations whereby a supply of fresh air is secured to these dwellers in the water. Since insects, then, are so characteristically children of the air it is of special interest to find that some have established themselves close to, in, or on the waters of the sea. The immense number of different kinds of insects must make the struggle for life among them exceptionally severe, and the existence of marine insects is a striking proof of the hardship of the struggle. They have been driven to adapt themselves to life in salt water, just as thousands of the teeming human population of China have been driven to live in house-boats and junks.

The insect-fauna of the land and the freshwaters merges gradually into that of the sea. Many genera of aquatic insects have species which live in brackish water. There are many kinds of beetles, flies, and moths, rarely or never found elsewhere than on coast sand-dunes. These, however, live high and dry, and may be fairly regarded as terrestrial species. Nearer the water's edge, where the blown-sand passes into the beach, a row of blackened seaweed marks the limit of the high spring tides. In this a number of beetles may often be found; over it hover flies whose grubs are feeding in the decomposing mass below, and they must be able to bear at least occasional immersion. Right down by the water's edge, along the margin of the rock-pools, lurking in the seaweed covered twice daily by the waves, skimming over the surface-film, or swimming through the clear, calm water when the tide is out, the true marine insects must be sought for and studied. Still more daring invaders of the sea may be observed by the sailor-naturalist in tropical climes. He will find some relations of our common pond-skaters, skimming over the waters of estuaries or harbours where his ship lies becalmed, and he will meet with others on the open ocean hundreds of miles from land.

Our survey of the insects of the sea will best be taken order by order. The representative of the most primitive of the orders—the Bristle-tails (Thysanura)—may appropriately come first; though it lives close to the water's edge, it seems rarely or never to be covered by the tide.

BRISTLE-TAILS.

The marine member of the order Thysanura is the

* "Manual of Marine Zoology for the British Isles," Part I. p. 178. London, 1855.

† "On Insects inhabiting Salt Water." *Amer. Journ. Sci.*, 1871; *Ann. Mag. Nat. Hist.* (4), VII., pp. 230–240.

‡ "Acariens et Insectes marins des Côtes du Boulonnais." *Rev. Biol. Nord, France*, II., 1889–90.

§ "The Natural History of Aquatic Insects," London, 1895, ch. XII.

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insect which was described by Leach in 1815 as *Machilis maritima*. These Bristle-tails may be found in numbers around the rocky parts of our coasts, sometimes lurking under stones, sometimes disporting themselves in the sunshine on the smooth sides of a rock-pool. They can run with a swift, gliding motion over the surface of the rock, and are able to leap nimbly when disturbed. Without reckoning the long feelers and tail bristles, *M. maritima* measures about 12 mm. ($\frac{1}{2}$ inch) in length (*see* Fig. 1).

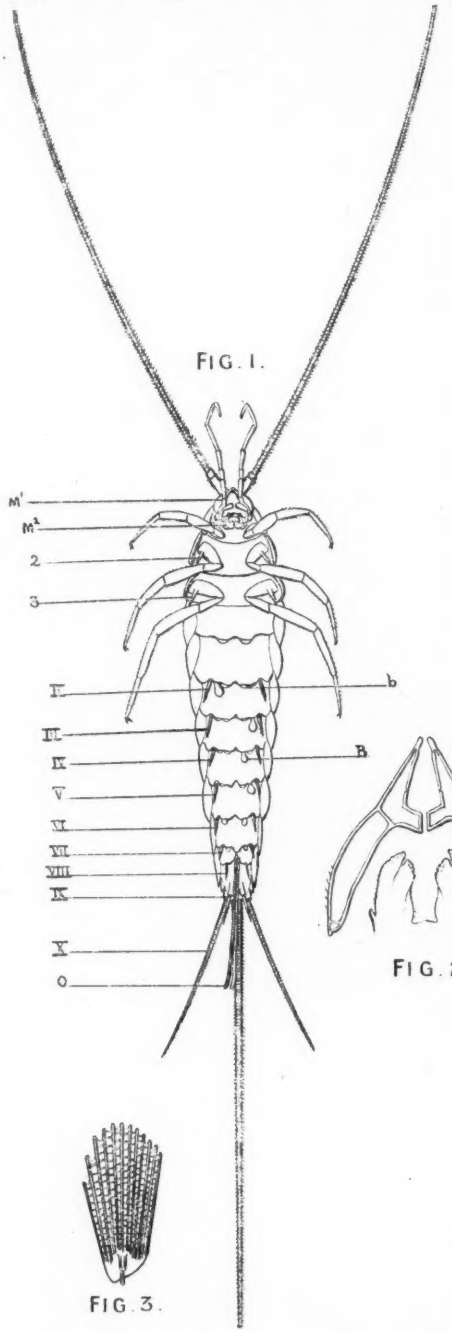
The structure of Bristle-tails is of great interest to naturalists, since these insects have retained a number of primitive characters. They remain wingless throughout life, and they are especially remarkable in having paired limbs on several of the hind-body (abdominal) segments. It is believed, therefore, that they represent to some extent the far-off, many-legged, ancestors of our present-day six-legged insects. In Machilis these abdominal limbs (Fig. 1, II.-X.) are more numerous than in any other genus of the Thysanura, being present on all the segments, from the second to the tenth inclusive. Those borne on the tenth segment are the long, jointed, bristle-like organs, known as cercopods, which are to be seen also in some winged insects—mayflies and stoneflies, for example.

But a point in the structure of the Machilis suggests that though these abdominal limbs may tell us of ancestral forms with many pairs of legs, yet they do not correspond exactly with the six legs of the thorax. The haunch in the second and third pairs of legs in Machilis carries, in addition to the functional legs, a small pointed hairy appendage (Fig. 1, 2-3), which agrees closely in form and size with the abdominal limbs. It seems, likely, therefore, that two-branched limbs occurred on all the segments in the ancestral form, and that the inner branch persists as the functional limb of the thorax in insects generally, while the outer is preserved in the abdominal appendages of the Bristle-tails.

Close to these limbs we find small bladder-like sacs, which can be withdrawn (Fig. 1, *b*) or pushed out (Fig. 1, B), at the will of the insect. There is a pair on each of the first, sixth, and seventh abdominal segments, and two pairs on each segment from the second to the fifth inclusive. J. T. Oudemans,‖ to whose researches we owe most of our knowledge about *Machilis maritima*, gave much attention to the structure and probable use of these organs, and came, somewhat doubtfully, to the conclusion that they have a respiratory function. When thrust out, they contain blood, and they might well be used to absorb air in damp situations. But Machilis breathes also, like the higher insects, by means of air-tubes. These open to the exterior by paired air-holes (stigmata) on the two hindmost thoracic segments and the second to the eighth abdominal segments inclusive. The branching systems of tubes leading from the various air-holes remain separate; they do not, like those of the winged insects, unite to form continuous trunks and networks.

Like some other Bristle-tails—the well-known "Silver Fish insect" (*Lepisma*) of our houses, for example—Machilis is covered with scales, resembling those found on the wings of moths and gnats. The scales of Machilis (Fig. 3) are of large size, about .1 mm. in length, and are stiffened with thickened rods running lengthwise; between these, short transverse markings can be distinguished arranged like the rungs of a ladder. The scaly covering of *Machilis maritima* gives to the insect during life a dark mottled aspect, which often agrees closely with the appearance of the rocks among which it

‖ "Beiträge zur Kenntniss der Thysanura und Collembola." *Bijd. tot de Dierkunde* (Amsterdam), XVI., 1888, pp. 147-227, pls. I.-III.



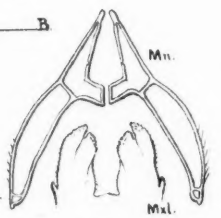


FIG. 2.

FIG. 3.

FIG. 1.—*Machilis maritima*, Leach. Female seen from the Ventral Aspect. M^1, M^2, first and second pairs of maxillæ; 2, 3, appendages on haunches of second and third legs; II.—X., limbs on abdominal segments; O, ovipositor; B, protruded, and b, withdrawn bladder-like sacs on abdominal segments. Magnified 5 times.

FIG. 2.—Mandibles (Mn.), and Maxillulæ (Mxl.) of Hansen ("paraglossæ" of most authors) dissected out of the head. Magnified 20 times.

FIG. 3.—A Scale from the Back. Magnified 25 times.

lives. Similar protective colouring is to be seen in our other British species—*M. polypoda* (Linn.)—which is often abundant in stony places in the hill-countries.

For our knowledge of the habits of *Machilis maritima*, as of its structure, we are chiefly indebted to Oudemans. He observed the insects carefully on the Dutch coast, where they frequent the stones of dykes and sea-walls, and the wooden piles of sluices. From May to November they are very lively, and often wander about singly. "It seems," he writes, "that they greatly like warmth. I have seen them on a hot August day run and leap very briskly on the hot stones of a dyke." In winter they withdraw into holes and chinks, where they crowd together in great numbers. Only full-grown individuals are to be seen in autumn and winter, but both adults and young in midsummer, whence it follows that the young are hatched in spring, and that the insects live for more than a year. "They are," writes Oudemans, "very inquisitive. If I approached a place (except in winter time) where they were to be found they usually came to the light. Did I approach too near, they began to run and jump about. If they fall into the water it does not matter, since they are hardly wetted thereby. They can move over the surface-film of the water, and even make short leaps thereon. Usually they reach the shore again after a short time, or find an object up which they can climb. I have often seen this." He goes on to describe how he kept specimens in captivity on the surface-film of water in a glass vessel up whose smooth wall they could not make their way. "They remained there forty-eight hours. When, afterwards, I gave them a chance of regaining dry land, they took the opportunity, and were perfectly right again after a few moments." It seems, therefore, that Machilis is well enough adapted to a life by the sea-shore. They appear to feed on vegetable refuse, but, like many creatures higher in life's scale, they fast during winter.

No one can examine Machilis without being struck by its general likeness to some other, and more familiar, creatures of the sea-shore—the sand-hoppers and their relations belonging to the crustacean order Amphipoda, which have lately been so ably described in these columns by Mr. Stebbing. Everyone knows that the Crustacea form a class of animals distinct from the Insecta, yet both classes are included in the great Race of jointed-legged animals or Arthropoda. Very diverse opinions have prevailed among zoologists as to the relationship between insects and crustaceans. It was at one time thought that the Bristle-tails, the most primitive of insects, as well as the crustaceans, could be traced back to an ancestral form resembling the well-known zoëa-larva of a crab.¶ Of late years, however, less importance has been attached to larvæ as indicative of relationships, and the view that there is but little connection between insects and crustaceans has been gaining ground.** But quite recently the problem has been attacked from a fresh point of view, and a rather close relationship between the Bristle-tails and the lower malacostracous Crustacea—the Amphipods and Isopods—has been advocated by the Swedish zoologist Hansen.††

It is well known that a typical insect, like a cockroach or a beetle, has three pairs of jaws—a pair of mandibles and two pairs of maxillæ, the second of which are more or less completely fused together to form a "lower lip" (*labium*). In Crustaceans we also find a pair of mandibles and two pairs of maxillæ, but in the Amphipods and Isopods the next pair of limbs, the first jaw-feet or maxillipeds, are also included in the head region, and become partially joined to form a "lower lip." Now Hansen has suggested that a pair of structures found in the head of the Thysanura, united basally with the tongue, especially well developed in *Machilis* (Fig. 2, Mxl.), and situated between the mandibles and maxillæ, are in reality a pair of jaws which correspond with the first maxillæ of crustaceans. If this view be correct, there are four pairs of jaws in the Bristle-tails, and the correspondence of these insects with the sand-hoppers, woodlice, and their relations becomes remarkably close, especially when we remember that the number of segments behind the head is exactly the same (thirteen) in both groups. Hansen states that vestiges of these "maxillulæ" are to be found in the cockroach and other insects; the Bristle-tails, therefore, seem to have retained a pair of jaws which the higher members of the class have almost or altogether lost. The mandibles of the Thysanura, too (Fig. 2, Mn), have many points of likeness to those of crustacea. Another correspondence with the sand-hoppers and woodlice is brought out by Oudemans, who states that the eye in Machilis as in those crustaceans has a layer of hypodermis-cells between the corneal facets and the crystalline cones.

As we watch *Machilis maritima* disporting itself around the rock-pools, the enquiry is suggested as to the various coasts which it haunts. All around the shores of our own islands—even to the remote Orkneys and Shetlands, as well as the Irish Aran—it has been found; as also on the rocky coasts of Norway, of Holland, of France, and Spain, and even on the Canary Isles lying out in the Atlantic off the shores of North Africa. It does not seem to range to the eastern European coasts.

So far as we know, Machilis is incapable of crossing a sea-channel of any breadth. Its presence on these various western continental and island shores tends to show, therefore, that at some former period there must have been a continuous continental coast-line along which it could migrate. This humble insect furnishes one of the many distributional facts which point to the existence in Tertiary times of continental land lying north and south along the western margin of the present European area. And its presence on the Canaries lends support to the view—once highly popular, then discredited, now beginning again to find upholders—that this old western continent may have stretched away far into the Atlantic.

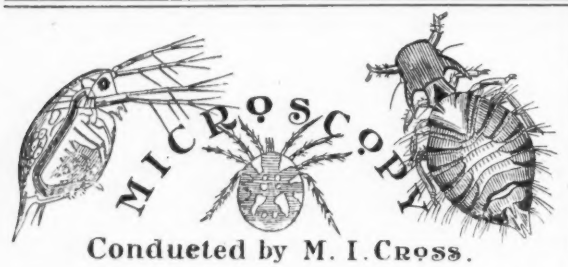
The mere fact that our little Bristle-tail haunts these rocky coasts calls up visions of a vanished continent, and shows how land and sea areas have changed in the course of the earth's history. And when we study the structure of the insect we are carried back to a past still more remote. As we see a Machilis gliding over some ancient Archaean rock, we imagine the primaeval sea in which the fragments of that rock gathered as sediment. In that same sea, maybe, lived the far-off common ancestors of the insects and crustaceans of to-day. No "record of the rocks" preserves the form of these primitive arthropods for our study; but we can guess at their nature by help of those characters which, passed on through countless generations of living creatures, still survive in our marine Bristle-tail.

¶ E. Haeckel. "The History of Creation." London, 1876.

** F. W. Hutton and others "Are the Arthropoda a Natural Group?" *Natural Science*, Vol. X., 1897, pp. 97–117.

†† "A Contribution to the Morphology of the Limbs and Mouth Parts of Crustaceans and Insects" *Ann. Mag. Nat. Hist.* (6), XII., 1893, pp. 417–434. *See also Nat. Sci. (loc. cit.)*, pp. 103–5.

XUM



Conducted by M. I. CROSS.

STANDARD SIZES FOR EYEPIECES.—On December 20th, 1899, the Council of the Royal Microscopical Society adopted certain internal diameters of draw-tubes as standards for eyepiece sizes; withdrawing those which had been fixed by them in the year 1882, which were two in number, viz.: ·92 in. for small stands, and 1·35 in. for large.

The following were the sizes decided upon:—

No. 1, ·9173 inch = 23·300 m/m.
„ 2, 1·04 „ = 26·416 „
„ 3, 1·27 „ = 32·258 „
„ 4, 1·41 „ = 35·814 „

A year has gone by, and it is now possible to estimate the value of these fresh gauges and to ascertain the probability of their regular and general use. We are indebted to the courtesy of manufacturers for statements of their intentions on the subject, and although several have abandoned old sizes for the new ones, or intend to do so, there yet remain some who do not seem disposed to consult the public convenience by falling into line. It will be apparent that No. 1 gauge is the one known as the "Continental size," and is practically the same as the smaller gauge recommended by the Royal Microscopical Society in 1882. This is almost the universal diameter for student's microscopes, and its popularity shows no likelihood of diminishing. The No. 2 gauge is differently placed, and it is not unanimously agreed that its inclusion in the list is either necessary or advantageous. The number of microscopes in which this is likely to be used is extremely limited. The No. 3 gauge is very suitable for stands of medium size, but No 4 is of questionable value, for the day for the large models to which this gauge would be applicable seems to have passed. All considered, it would seem that both the public and the manufacturers would have been better placed had three sizes only been fixed, and in view of present knowledge and experience, a confirmation of the sizes of 1882, with the addition of an intermediate gauge, say the one of about 31 m/m., which was already in regular use, would have been a very convenient and acceptable range. The net result will probably be, as time goes on, that gauges Nos. 1 and 3 will become the standards, and it is to be hoped for the sake of uniformity that No. 2 at least may be withdrawn. The fewer the number of gauges the better for everyone. The prevailing tendency is to have a large tube, and with a fitting at the eyepiece end to receive eyepieces of the No. 1 gauge; after all, if the body be of sufficiently large diameter for photography, it does not matter greatly whether the eyepiece be large or small, for only in the oculars of *very* low power can a large field lens be used in the eyepiece. We are informed that a general meeting of German microscope manufacturers is shortly to take place, and it is possible that some consideration may be given to the recommendations of the R. M. Society on the subject of both eyepieces and sub-stage fittings. Universal sizes are of such prime importance that it is to be hoped that the random system which has too long prevailed, of every maker being a law unto himself, will be unknown in the future, and as workers realise that the standard sizes are an actual fact, they will insist on their incorporation in their stands, and so induce those makers who might otherwise be disinclined to alter the diameters of their tubes voluntarily, to meet the exigencies of modern work by using only the universal fittings of the Royal Microscopical Society.

BLOOD EXAMINATION.—In recent years the examination of blood for diagnosis of diseases, especially those peculiar to tropical climates, has assumed great importance, and every practical suggestion which enables it to be more thoroughly performed is welcome. We have had sent to us the description of a method devised by Dr. W. L. Braddon, of the Malay Peninsula, which is both interesting and effective. The corpuscles are examined in a film between (1) two square cover-glasses joined together, or (2) a square cover-glass attached to a 3 in. by 1 in. slide. Slides and cover-glasses are first of all sterilized by the method recommended by Messrs. Pakes and Howard, which is as follows:—The cover-glasses are dropped, *one by one*, into a 10 per cent. solution of chromic acid, contained in an enamelled iron dish, and boiled for twenty minutes. They are then tipped altogether into a shallow basin, and washed with ordinary tap-water, until all trace of the yellow colour of chromic acid has disappeared. The water is next poured off and the slips are covered with rectified spirit. After this they are washed in absolute alcohol, and handled with clean forceps." These cover-glasses and slides are then dealt with as follows:—

Method No. 1.—Two square cover-glasses are accurately superposed and firmly pressed together. An edging of vaseline if for temporary purposes, or cement if for permanent purposes, is laid over all the edges, except one, which is left free, and a very small portion of that edge which is opposite to the uncemented one.

Method No. 2.—The cover-glass is placed on a 3 in. by 1 in. slide in such a position that one of its edges exactly coincides with that of the slide. It is then firmly pressed and vaseline or cement is used, as mentioned in Method No. 1.

Method of Use.—A drop of blood is touched with the free edge of the paired cover glass or slide, whereupon the blood enters between the glasses in an exceedingly thin film, the corpuscles being spread out with beautiful uniformity, and having suffered a minimum amount of change from exposure to air and none at all from handling or pressure. When the blood film has entered, the free edge may be completely closed and the examination made. Fresh blood keeps well under these circumstances The advantages of these methods will be obvious. A number of slides can be made up and stored in a suitable air-tight bottle, and are always ready for use. No special skill is required for the making of a first-class blood-film.

Comments.—We have tested this process practically, and found that it was necessary to put the smallest possible suggestion of cement between the covers before edging them outside, otherwise the cement had a tendency to run in. When the blood enters beneath the cover, so attenuated is the film that the manipulator is apt to imagine that nothing is there, but, on examination under a microscope, a beautiful single layer of corpuscles is seen, spread out ready for examination.

DISSECTING WITH AN ERECTOR.—The ordinary compound microscope is not used as largely as it should be for dissecting purposes, one of the special instruments designed for the work being usually considered essential. As a matter of fact, any monocular microscope having a draw-tube will serve well if an erector be used. Nearly all the modern stands are fitted with a thread of the universal size at the lower end of the draw-tube, and into this the erector should be screwed. The objective that will be found most useful in conjunction is 1½in. or 2in., and a considerable variety of magnification can be secured by varying the extension of the draw-tube, the object, of course, being seen the right way up, and the tools, knives, &c., moving in natural directions. The reason why the erector has not been recognised as so useful an adjunct as it might have been, is probably because unsuitable objectives have been used with it, but the amateur preparer will be surprised at the great ease with which he can do his work with the arrangement above mentioned.

NEW APPARATUS.—It is proposed, instead of systematically reviewing new apparatus from time to time, to have a heading for "*New apparatus described by manufacturers*," and opticians who wish to notify the introduction of fresh accessories, instruments, &c., will briefly state the details for insertion. It is impossible to give a definite judgment on any item from an examination of a single specimen, and the public being made aware of the source of supply of such wares, will be better able to judge of their suitability for their requirements by communicating with the vendor, who would surely be pleased to give full information on the subject.

NOTES AND QUERIES.—Notes and suggestions will always be welcomed from readers, and any assistance we can give by replies to queries in these columns will be gladly rendered. All communications for this column should be addressed to M. I. CROSS, KNOWLEDGE Office, 326, High Holborn, W.C.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

BRORSEN'S PERIODICAL COMET.—This object is approaching the earth and increasing in apparent brightness. It ought to become visible at the end of January, and particular interest attaches to this return as the comet has not been seen since 1879. The following is extracted from an ephemeris by Berberich in *Ast. Nach.*, 3670:—

Date. 1900.	R.A. H.	M.	Dec. °	′	Distance of Comet in Millions of Miles.
January 14 ...	20	35·0	−16	24	... 37
„ 18 ...	20	7·6	− 9	37	... 37
„ 22 ...	19	42·1	− 3	28	... 40

On January 18th the comet will be about 4° N. of α Capricorni and moving rapidly to N.W.

COMETARY DISCOVERIES IN 1900.—These were comparatively few and unimportant. Giacobini found a faint comet on January 31st, which remained visible for several months in large instruments. Its light was, however, so feeble that many observers with small telescopes were disappointed in their efforts to pick it up. On July 23rd Borrelly discovered a pretty bright comet with a tail. The object was independently swept up by Brooks a few hours later. The comet was a very interesting and fairly conspicuous one during several weeks, being visible all night in the northern sky. Parabolic elements appear to satisfy the observations in both cases. No periodical comets have been redetected during the year.

THE LEONID METEORIC SHOWER.—The Leonids again failed to put in an appearance, and we have only to admit the fact that planetary perturbation has disturbed the stream to such a degree that the denser portion was enabled to escape encounter with the earth. After the negative results of 1898 and 1899, we were better prepared to accept failure in 1900, but the general result of observation is, nevertheless, very disappointing. The present generation had been led to expect one of the most striking and picturesque of all natural phenomena, and its almost complete absence is very regrettable on many grounds. Apart from the disappointment so widely felt, the public may be induced to entertain questionable views as regards future astronomical predictions. Perhaps it would have been much better had the computations relating to the Leonids been made several years ago, so that the public could have been fully advised as to the doubtful character of the shower's return. The work was, however, left until very late, and a good many astronomers deluded themselves and others with a mistaken confidence that the event would return quite in accordance with its usual period and traditions. It is unfortunate that, as a rule, amateurs though pretty good observers are bad computers, while professional astronomers, though not always first-class observers, are good mathematicians. The latter class cannot be expected to undertake an elaborate investigation without payment, and so the matter was delayed beyond reasonable limits. We may take comfort in the reflection that the Leonid showers are not finally lost to us. Planetary influences may affect the stream in a manner contrary to that which has operated since 1866, and bring back the rencontres which gave rise to the magnificent meteoric storms of 1799 and 1833. But for the present generation of meteor-watchers the prospect seems a very poor one, though 1901 and 1902 may bring us a few laggard members of the denser region of the stream. There will be no moonlight at the middle of November, 1901.

A large number of reports have been sent in concerning recent observations, but they are uniformly of a negative character. The Leonids were most active on the morning of November 16th, when the radiant furnished two or three meteors per hour for one observer. The radiant was at about 150° + 22°. The most active of the contemporary showers was the Taurids, with a radiant at 57° + 9°, which supplied some fine slow-moving meteors, with long paths and trains of yellow sparks. These Taurids are often conspicuously present during watches for the Leonids, and the stream yields an unusual proportion of brilliant fireballs.

In the presence of a notable dearth of Leonids it is satisfactory that one of these meteors, which appeared on November 13th, at 13h. 32m., was observed by Prof. A. S. Herschel at Slough, and by the writer at Bristol. It was of the second magnitude, and descended from a height of 69 miles near Wallingford to 58 miles near Swindon, traversing a real path of 24 miles with a velocity of about 48 miles per second. Several other meteors have been doubly observed, and the full comparison of the various observations appears likely to add some interesting items with regard to the minor showers of the period.

FIREBALLS OF NOVEMBER 17.—Several fireballs were observed on this night, but they were not very exactly recorded. The first appeared at about 7 p.m., and there was an exceedingly brilliant one at 11h. 32m. Some large meteors were also recorded on December 13th, at 7h. 40m., 9h. 20m., 11h. 58m., and 12h. 26m. Like October 21st, the nights of November 17th and December 13th seem to have exhibited some meteoric displays of rather exceptional character.

THE FACE OF THE SKY FOR JANUARY.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 8.8 A.M., and sets at 4 P.M.; on the 31st he rises at 7.43 A.M. and sets at 4.45 P.M. On the 2nd, at 9 P.M., the earth is at its least distance from the sun, the horizontal parallax being 8·95″; the sun has then its maximum apparent diameter of 32′ 35″·2. Few spots are to be expected.

THE MOON.—The moon will be full on the 5th at 0.14 A.M., will enter last quarter on the 12th at 8.38 P.M., will be new on the 20th at 2.36 P.M., and will enter first quarter on the 27th at 9.52 A.M. The following are among the occultations visible at Greenwich during the month:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Jan. 5	1 Cancri	5·9	9.45 P.M.	129	165	10·50	258	286	14 22
„ 6	A^1 Cancri	5·6	6.36 P.M.	108	145	7·31	277	317	15 19
„ 28	13 Tauri	5·4	8.3 P.M.	9	354	8·28	331	310	8 6
„ 28	14 Tauri	6·4	8.32 P.M.	43	20	9·28	302	270	8 7
„ 29	D.M. + 20°785	5·8	6.0 P.M.	76	106	6·37	268	290	9 4
„ 31	χ^1 Orionis	4·7	2.41 A.M.	110	69	3·36	268	229	11 13

THE PLANETS.—Mercury is not well placed for observation, being in superior conjunction with the sun on the 22nd.

Venus is still a morning star, gradually becoming less favourably placed for observation. On the 1st she rises shortly before 6 A.M., and on the 31st about 6.40 A.M. On the 15th the apparent diameter is 10·6″, and the illuminated part of the disc is 0·902.

Mars, in Leo, rises on the 1st at about 9.20 P.M., and on the 31st about 7.10 P.M. On the 15th the apparent diameter is 13·8″, the illuminated part 0·949, and the horizontal parallax 12·9″. Though the approaching opposition of February 21st is an unfavourable one as regards the distance of the planet from the earth, there is some compensation in the fact that the altitude of the planet when near the meridian is much greater in our latitude than in the oppositions, when the distance of the planet is smaller.

Eros is still favourably situated, and the following abridged ephemeris, for Berlin midnight, may be useful to those wishing to observe this interesting object:—

	Right Ascension. H.	M.	S.	Declination. °	′	″
February 1 ...	3	43	52	... +24	52	17
„ 6 ...	4	2	21	... 22	52	11
„ 11 ...	4	21	0	... 20	54	49
„ 16 ...	4	39	43	... 19	0	40
„ 21 ...	4	58	25	... 17	10	10
„ 26 ...	5	17	2	... +15	23	38

The apparent stellar magnitude of the planet ranges from 8·5 to 9·0 during the month.

Jupiter, Saturn, and Uranus are too near the Sun to be conveniently observed.

Neptune remains in Taurus, and may be observed throughout the night. The path is a short westerly one, nearly midway between ζ Tauri and η Geminorum.

THE STARS.—About 9 P.M. at the middle of the month, Ursa Major will be in the north-east; Leo and Cancer towards the east; Gemini high up, and Canis Minor lower in the south-east; Auriga and Perseus nearly overhead; Orion and Taurus nearly in the south; Aries and Cetus towards the south-west; Pegasus and Andromeda in the west; and Cygnus in the north-west.

Minima of Algol occur at convenient times, on the 3rd at 11.7 P.M., the 6th at 7.56 P.M., the 26th at 9.39 P.M., and on the 29th at 6.28 P.M.

XUM

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of December Problems.

No. 1.

(Jeff Allen.)

1. Kt to Q5, and mates next move.

[This Problem, which has been much admired, has puzzled effectually one of our most reliable solvers.]

No. 2.

(Major Nangle.)

Key move—1. K to B4.

If 1. . . . P to K4ch, 2. K×P.
1. . . . P to K3, 2. K to K5.

CORRECT SOLUTIONS of both problems received from Alpha, H. S. Brandreth, G. A. Forde (Capt.), F. N. Worsley-Benison, H. Le Jeune, W. Nangle (Major), J. Blaikie.

Of No. 2 only from W. de P. Crousaz, J. Bernard Corp.

H. Boyes.—No. 1, If 1. R×Kt, B to B5, and there is no mate. In No. 2 you overlook after 2. B to B2, P×B.

A. Murdoch.—See answer to H. Boyes. In No. 2, after 1. B to Q4, P to K4; 2. B×BP, K to B7; 3. Q to Ksq is not mate.

J. Bernard Corp.—If 1. B to Kt6ch, Black interposes the Pawn or Knight. The King cannot go to K4 as you suggest.

F. N. Worsley-Benison.—Your solutions last month were correct, but received several days too late to acknowledge in the last number.

The Solution Tourney begins with the following Problems. The conditions were given last month, but it may be as well to repeat them. The first prize is One Guinea; the second, KNOWLEDGE free for twelve months:—

CONDITIONS.

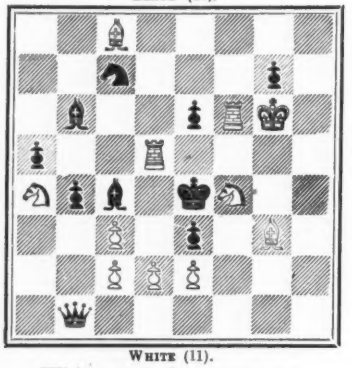
1. The Tournament will begin on January 1st, 1901, and will include all the direct mates in two and three moves printed in KNOWLEDGE during the year 1901.
2. If a Problem be incorrectly printed it will be cancelled and reprinted.
3. Key-moves only need be given. A correct key to a two-move Problem will score two points, to a three-move Problem, three points. A *second* solution will score one point. An incorrect claim for a second solution will lose one point. If a Problem has no solution, the fact must be stated; it will then count as a correct key.
4. In the event of a tie for either prize, the Chess Editor may decide it by a further trial of skill under new conditions.
5. Solutions must bear postmark not later than the 10th of the month of publication.

PROBLEMS.

By W. Geary.

No. 1.

BLACK (10).

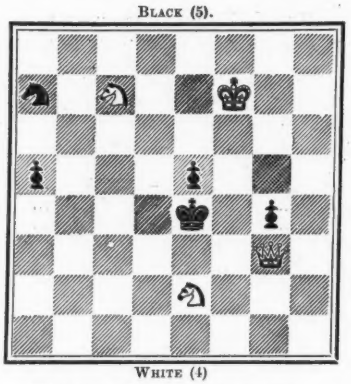


WHITE (11).

White mates in two moves.

No. 2.

BLACK (5).



WHITE (4)

White mates in three moves.

CHESS INTELLIGENCE.

An important tournament has recently been concluded at the Manhattan Chess Club, New York. With the exception of Messrs. Pillsbury and Barry, all the most prominent American players were competing. The final score was:—1, S. Lipschütz, 8; 2, J. W. Showalter, 7; 3, A. B. Hodges, 5; 4, E. Hymes, 4; 5, D. G. Baird, 3½; 6, F. J. Marshall, 2½. The relative positions are not surprising, with the exception of Mr. Marshall's failure, which is unaccountable after his recent successes. It is understood that he will compete with Messrs. Pillsbury and Showalter, at the forthcoming Monte Carlo tournament.

In the South-Eastern section of the Southern Counties' Chess Union Competition, Kent have defeated Hampshire by 7 games to 2, the other seven games being drawn. Kent are a greatly improved side, while their opponents seem to have fallen off latterly.

In the North *v.* South correspondence match of 50 players aside, Mr. Burn, at Board No. 1, has won one game from Mr. Gunston, a draw being agreed to in the other game. At Board No. 2, Mr. Locock is a Pawn ahead in both games against Mr. Schott.

A tournament is now in progress at Simpson's Divan, Messrs. Lee, Mortimer, Müller, Teichmann and Van Vliet being the competitors. Mr. Mortimer is also taking a prominent position in the tournament of the British Chess Club. In the City of London Tournament Mr. E. O. Jones has won his first eight games, but apparently not against the strongest players. Messrs. T. F. Lawrence, Herbert Jacobs and Dr. Smith have also made good scores.

For Contents of the Two last Numbers of "Knowledge," see Advertisement pages.

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